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THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1901

BY

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RALEIGH

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., May 1st, 1902.

To His Excellency, HON. C. B. AYCOCK,
Governor of North Carolina.

SIR:—I have the honor to submit for publication, as the sixth of a series of economic papers, a report on the *mining industry* in North Carolina for 1901. Its publication is intended to meet inquiries that are constantly being received at this office for information concerning the condition of the mining industry and the different minerals that are being mined in the State. It takes up more in detail than the report of last year, descriptions of the occurrences of economic minerals in the State, and calls attention to those that are worthy of further investigation and that give promise of developing into remunerative properties.

Yours obediently,

J. A. HOLMES,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1901.

INTRODUCTION.

The first year of the new century (1901) that has just closed has seen a decided gain in the mining industry of North Carolina. There has been an increased production of minerals and a progressive substantial development of mineral properties. The most notable features of the mining industry are the very extensive developments that are being carried on in the Person county and Ashe county copper belts; the increased demand for monazite; and the large increase in the production of kaolin and talc. Among the iron mines there has been a slight increase in the development of properties, but the production has been confined to one mine. In the gold fields there has been a steady advance in the manner in which new properties have been opened up, and old ones put into shape to become producers.

There are many natural advantages that are favorable to mining operations in North Carolina. The mining fields are all within easy distance of the large business centers; thus leaving New York at 4:30 P. M., North Carolina is reached early the next morning and by the same night nearly any mining camp in the State can be reached. Labor is cheap, although really skilled labor commands about the same price here as in other southeastern States, but is much less than corresponding labor in western mining camps. Climatic conditions permit of nearly continuous mining throughout the year. Most of the mines are in proximity to railroads and also centers of mining supplies, as Charlotte and Salisbury; and to timber for lumber and cordwood which can be obtained at a low cost. Another important advantage is the abundance of water-power that is available at many of the mining localities, which would make practicable the installation of electric power plants. While there have been some failures in

mining during 1901, there has been less speculative mining than for many years; and the mining and prospecting that is being carried on is along legitimate lines. That this is reacting favorably is apparent from the renewed interest that capitalists are now taking in North Carolina mining propositions, and the large amount of money that is being systematically spent in the development of mines and mineral properties.

Often, when occasions arise that increase the demand for a certain mineral; or trade conditions change so that new sources of supply are imperative; or new industries spring up that call for certain minerals for their manufacture, these minerals are found in large quantities where, in many cases, they were formerly supposed to be rare. North Carolina has furnished many of these, and when there is a demand for a new commercial mineral it is one of the first States that is looked to to furnish the supply. Every year minerals new to the State are being added to the list and frequently a new mineral species is discovered, thus constantly increasing the variety of minerals to be found within the Commonwealth.

It may be of some advantage as well as of interest to give here a list of the minerals that have been found in the State, and to indicate those that have a commercial value and of these, those that have been found in quantity in North Carolina. There are now 205 minerals that have been identified in North Carolina, some of which are new species that were first identified in this State, and these are indicated in the list below by the letter *a*.

List of Minerals Found in North Carolina.

1. Actinolite (an Amphibole).
2. *Albite** (a Feldspar).
3. Allanite.
4. *Almandite.**
5. Altaite.
6. Alunogen.
   Amazon Stone (Var. Microcline).
   Amphibole (Group name).
7. Anatase.
8. *Andradite.**
9. Andesine (a Feldspar).
10. *Anglesite.*
11. Anorthite (a Feldspar).
12. Anthophyllite.
13. *Anthracite Coal.*
14. *Antimony.*
15. *Apatite.*
16. *Arsenopyrite.*
17. Arfedsonite.
18. *Argentite.*
19. Arragonite.
20. *Asbestos** (an Amphibole).

21. Auerlite.[a]
22. Augite (a Pyroxene).
23. Autunite.
24. *Azurite.*
25. *Barite.**
26. Barnhardtite.[a]
27. *Beryl.**
28. Biotite.
29. Bismite.
30. Bismutite.
31. Bismuthinite.
32. *Bituminus Coal.**
33. *Bornite.**
34. Braunite.
35. Breunnerite.
36. Bronzite.
37. Brookite.
38. *Calamine.*
39. *Calcite.*
40. *Cassiterite.*
41. *Cerargyrite.*
42. Cerolite.
43. *Cerussite.*
44. Chabasite.
45. *Chalcanthite.*
46. *Chalcedony.**
47. *Chalcocite.**
48. *Chalcopyrite.**
Chlorite (Group name).
49. Chloritoid.
50. *Chromite.**
51. *Chrysocolla.*
52. *Chrysolite* (Olivine).
53. *Chrysoprase.*
*Chrysotile** (Var. of Serpentine).
54. Columbite.
55. *Copper.*
56. *Corundum.**
57. Covellite.
58. Crocidolite.
59. Crocoite.
60. Culsageeite.[a]
61. *Cuprite.*
62. Cuprosheelite.
63. Cyanite.
64. Cyrtolite.
Damourite (Var. of Muscovite).
65. Deweylite.
66. *Diamond.*
67. Diaspore.
68. Diopside (a Pyroxene).
69. *Dolomite.*
70. *Dudleyite.*[a]
71. Dufrenite.
72. Edenite (an Amphibole).
73. Enstatite.
74. Epidote.
Feldspar.* (Group name).
75. Fergusonite.
76. Fibrolite.
77. *Fluorite.*
Fuchsite (Var. of Muscovite).
78. Gahnite.
79. *Galena.*
Garnet* (Group name).
80. *Garnierite.*
81. *Genthite.*
82. Glauconite.
83. *Gold.**
84. Goslarite.
85. *Gothite.*
86. *Graphite.**
87. *Gummite.**
88. *Gypsum.*
89. *Halite.*
90. Halloysite.
91. Hatchettolite.[a]
92. Hausmanite.
93. *Hematite.**
Hiddenite[a]* (Var. of Spodumene).
94. Hisingerite.
95. Hornblende (an Amphibole).
Hyalite (Var. of Opal).
96. Hydrofergusonite.
97. Hypersthene.
98. *Ilmenite.*
99. Iron (meteoric).
Itacolumyte (Var. of Quartz).
100. Jefferisite.
Kammererite (Var. Penninite).
101. *Kaolinite** (Kaolin).
102. Kerrite.[a]

103. Labradorite (a Feldspar).
104. Lazulite.
105. Leucopyrite.
106. *Lignite* (Brown coal).
107. *Limonite.**
108. Linarite.
109. Lucasite.[a]
110. Maconite.[a]
111. *Magnesite.*
112. *Magnetite.**
113. *Malachite.*
114. Marcasite.
115. Margarite.
116. Marmolite.
117. Martite.
118. Melaconite.
119. Melanterite.
120. *Microcline** (a Feldspar).
121. Mitchellite.[a]
122. *Molybdenite.*
123. Molybdite.
124. *Monazite.**
125. Montanite.
126. Montmorrillonite.
127. *Muscovite.**
128. Naryagite.
129. *Niter*
130. Octehedrite.
131. *Oligoclase** (a Feldspar).
132. Olivenite.
133. *Orthoclase** (a Feldspar).
134. *Opal.*
135. Paragonite.
Pargasite (Var. of Hornblende).
136. Penninite.
137. Pharmacosiderite.
138. *Phlogopite.*
139. Phosphuranylite.[a]
Picotite (Var. of Spinel).
140. Picrolite.
Pinite (Var. of Muscovite).
141. Pleonaste.
142. *Polycrase.*
143. Prochlorite.
144. *Psilomelane.*
145. Pseudomalachite.
146. *Pyrite.**
147. Pyrochlore.
148. *Pyrolusite.**
149. Pyromorphite.
150. *Pyrope.**
151. *Pyrophyllite.**
Pyroxene (Group name).
152. *Pyrrhotite.*
153. *Quartz.**
154. Rhodochrosite.
155. *Rhodolite.**[a]
156. Rogersite.[a]
Ruby Spinel (Var. of Spinel).
157. Rutherfordite.[a]
158. *Rutile.*
159. *Samarskite.**
160. Saponite.
161. *Sheelite.*
162. Schreibersite.
163. Scorodite.
164. Senarmontite (or Valentinite).
165. *Serpentine.**
166. *Siderite.**
167. *Silver.**
168. Sillimanite.
169. Smaragdite (an Amphibole).
Soapstone* (Var. of Talc).
170. *Sphalerite.*
171. *Sperrylite.*
172. Spessartite.
173. *Spinel.*
174. *Spodumene.*
175. Staurolite.
Steatite (Var. of Talc).
176. *Stibnite.*
177. Stilbite.
178. Stolzite.
179. *Succinite* (amber).
180. *Sulphur.*
181. *Talc.**
182. Tantalite.
183. *Tenorite.*
184. Tetrahedrite.
185. Tetradymite.
186. Thorite.
Thulite (Var. of Zoisite).

187. Titanite (Sphene).
188. *Topaz.*
189. Torbernite.
190. *Tourmaline.*
191. Tremolite (an Amphibole).
192. Troilite.
193. *Uraninite.**
194. Uranophane (Uranotil).
195. Vermiculite.
196. Vivianite.
197. Wad.
198. Wavellite.
199. Wellsite.*
200. Willcoxite.*
201. *Wolframite.*
202. Xanthitane.
203. Xenotime.
204. *Zircon.**
205. Zoisite.

Of these 205 minerals, those in italics are of commercial value and of these, those marked with an asterisk have been found in sufficient quantity in North Carolina to warrant either mining or further developing them. It is not at all improbable but that in the course of time some of these other minerals will have a commercial value, and that large deposits will be found of those which are now known to have a commercial value but which have thus far been found but sparingly in North Carolina.

The close of the first year of the new century shows a most promising increase in the mineral production of the State, the total production being $1,764,233.94 as compared with $1,604,078 in 1900. All indications are that at the end of 1902 there will be a large increase in the mineral production over that of 1901. Many mining enterprises are being conducted on a larger scale than before and by the combining of some of the smaller mines under one management, they could be worked to better advantage. The condition of the mining industry in North Carolina at the beginning of 1902 and some idea of its outlook for the future are given in the following pages, which take up in detail the mining operations of the various minerals.

GOLD.*

The North Carolina gold deposits have been worked more or less continuously since 1799, which is the first authentic account of gold having been found in the State. Since that time there has been over $22,000,000 worth of gold mined. Although this is a favorable record, yet at the present time the gold mining industry is not in a very

*See also Bulletin 10, N. C. Geol. Survey, On Gold Deposits of N. C.

active condition. The causes for this decline are the exhaustion in many mines of the free milling ores, and of the richer placer deposits; the methods employed in mining; and a lack of knowledge of the treatment of the sulphurets.

The area in which the gold deposits are known to occur is a broad one, embracing from 8,000 to 10,000 square miles of the middle and western counties. There are three types of occurrences of these ores, as follows: In quartz fissure veins, carrying either free gold, or gold-bearing sulphurets; impregnations of free gold and finely divided sulphurets in the country schists and slates; and the placer deposits.

There are in the neighborhood of 400 localities in the State that have have been mined for gold; but at the present time there are not over 15 mines that are being worked, principally in Cabarrus, Mecklenburg, Davidson, Stanly, Montgomery and Rowan counties. There have been a number of new gold properties opened up and developed during 1901, but the greater part of the work has been confined to old mines and properties, some of which have been quite extensively operated. While there has not been as much actual mining, as was expected, yet there has been a great deal of work done, the greater part of which has been systematic and valuable.

Improved methods and machinery are making it more possible from year to year to use ores that were formerly supposed to be of little value or of a too refractory nature to be economically worked. Then again, there has been too much of a tendency to operate the mines on too small a basis, and it will be found that if a number of these gold deposits are operated under one management, they will make a profitable investment, while they are unprofitable when worked separately. The establishment of a custom smelter at Charlotte will be a strong incentive to more active mining in Mecklenburg and neighboring counties. This smelter is being erected by the United States Smelting-Refining Company of New York. They will obtain a portion of their supply of ore from their own mines, but expect, however, to draw the larger part of the ore from other mines in the vicinity. This should be the means of the re-opening of many of the smaller mines and properties which are not capable of supporting a smelter of their own.

Treatment of Sulphuret Ores.

In the treatment of the Carolina sulphuret ores, consideration must be taken of the rocks in which they occur. A large proportion of these ores occur in a rock consisting essentially of argillaceous schists and slates that are interlaminated with thin layers or lenses of quartz. Some of these rocks were igneous in origin, but have been altered to their present condition. There are bands of these rocks that are impregnated with free gold and finely divided gold-bearing sulphurets. The metallic contents are usually heavier along the cleavage planes of the schists and where the free gold exists it is often in a very finely divided and flaky condition. On account of the fineness of the gold and the slimy condition of the crushed ore, there is considerable difficulty encountered in saving the gold. A portion of the gold can be saved by amalgamation, but the tailings from the plates must be treated either by the chlorination or cyanide process. When the ore is wholly or partially in the form of sulphides it must be roasted in order to free the gold before it can be treated by either of these processes.

In regard to the cost of roasting these sulphide ores of the Southern Appalachian region, the only figures available are those of Mr. Thies, superintendent of the Haile gold mine, Lancaster county, South Carolina,* and "it is evident from a perusal of his figures that the cost per ton can be considerably reduced by the use of McDougall or Herreshoff roasters. In Montana, where labor is higher and fuel is at least double what it is in the South, the cost for this character of work would not exceed 60c. per ton. Using the improved machinery now in use throughout the West and having the advantage of the low prices prevailing in the South, the cost should not exceed 50c. per ton.

"In reports by many eminent mining engineers, made during the past 20 years, the gold deposits of the South have been quite conclusively shown to contain an abundance of low-grade ore. The question has not been the amount of ore, but as to the economy of treatment. Within a radius of 20 miles of Salisbury, North Carolina, there are at least two dozen mines of unquestioned merit, not one of

*Eng. and Min. Jour., Oct., 1901.

which is in active operation to-day. It is quite evident then that the field is a large one, and a promising one for the introduction of a cheap process. The success of the chlorination process of Mr. Thies gives assurance that the cyanide process, when adapted to these ores, will be equally successful, and as it is relatively cheaper there is no question as to a choice between the two methods; the cost of dead roasting will be the same in both cases. The cyanide plant, however, will, it is believed, cost less to build, less to operate, and the cost for chemicals will be less. If the ores contain oxides or carbonates of copper, chlorination may be necessary. Where the copper occurs as a sulphide, there is no reason why the cyanide process cannot be used. The successful plants that have treated the ores by chlorination recovered on a $4 ore, $1.30 on the plates, $1.80 in concentrates, and the tailings carry 90c. The concentrates treated by chlorination yielded an extraction of 94 per cent., so that the total extraction of the assay value of the ore is only 75 per cent.

"In order to treat such ores economically a plant should have a capacity of not less than 50 tons per day. A roaster to successfully handle that amount of ore per day will cost not less than $10,000 when erected and ready for operation; the necessary cyanide vats, agitators, etc., will cost in the neighborhood of $1,000 or $2,000 more, and a working fund of $10,000 should be allowed for mine development."*

Judging from the treatment of the slimy ores in various mills in Montana, the cost of mining and milling these ores should not exceed $2 per ton; of course, tailings could be treated much cheaper. A prominent cyanide man, after visiting the Howie mine and other deposits in North Carolina and Georgia, wrote,† "that he knows of no more promising field in the United States for the extension of the cyanide process; that it possesses so many decided advantages over other sections that those who now take advantage of the situation and the low valuation at which the properties are held are certain to be richly rewarded. With the selection of a property worthy of a good plant and the exercise of the same business prudence and sagacity

*W. H. Weed, Eng. and Min. Jour, Oct. 19, 1901.
†Eng. and Min. Jour., Oct. 19, 1901.

in operating it that would be needed in other lines of industry, one is certain to be remunerated to an extent far beyond what one could hope for from any other merchantile investment."

Localities.

There has been but little work done in 1901 in what is called the Eastern Carolina gold belt, which covers an area of about 300 square miles in Warren, Halifax, Franklin and Nash counties, and extends in a northwesterly direction from the Thomas mine, 1½ miles northeast of Ransom's Bridge, to and across the Tar river. Among the mines of this belt are the Thomas, Kearney, Taylor, Mann, Davis, Nick-Arrington, Mann-Arrington and Portis, the two latter being the most important. The principal work was done on the properties in the vicinity of the Portis mine, Nash county, where there has been some sluicing of the placer deposits and also on the Davis property.

The principal mining district of the Carolina belt is in the vicinity of Gold Hill, Rowan county. It is situated about 14 miles southeast of Salisbury in the southeast corner of Rowan county and extending into Cabarrus county on the south, and Stanly county on the east. The country rocks are chloritic and argillaceous schists, striking N. 25° to 30° E. and dipping 75° to 85° N. W. A diabase dike cuts the schists near the village of Gold Hill. The ore bodies consist of certain portions or bands in the schists that are impregnated with auriferous pyrite and of imperfectly conformable lenticular veins and stringers of quartz. There are six well defined approximately parallel veins in this district, known as the Randolph, Barnhardt, Honeycut, Standard, Trautman and McMakin. The principal work being done in this district for gold is by the Whitney Reduction Company, who are operating at and near the old McMakin mine. They have developed their mine by three shafts, the deepest one being about 600 feet, with cross-cuts between them. A well formed ore body has been blocked out that assays very favorably. In connection with their mining this company are developing the water-power at the Narrows of the Yadkin river and will erect their stamp-mill at this point. The Gold Hill Copper

Company expect to begin work at the Barnhardt mine during the coming year. The Union Copper Mining Company are mining principally for copper, but obtain more or less gold and silver as by-products. See page 20.

In Montgomery county one of the most noted mines is the Russell, which is about 3 miles northeast from Eldorado, and but a short distance from the Randolph county line. The country rocks are argillaceous slates, both of soft and silicified types. In part at least these slates are sedimentary and have a variable strike and dip. The ore beds consist of parallel belts in the slates impregnated with iron sulphurets (pyrite), and free gold together with some quartz stringers. The principal work at this mine consists of a big cut about 300 feet long by 150 feet wide and 60 feet deep. On the eastern edge of this cut is a shaft 150 feet deep, from the bottom of which the ore has been stoped upward. This mine is one of considerable promise and as far as can be determined contains low grade ore in quantity.

Some of the other principal mines and properties in this county are the San Christian, Appalachian (or Cogging), Morris Mountain, Riggon, Hill, Steel, Saunders, Marratock, Beavers Dam and Buck Mountain.

The Reed mine in Cabarrus county is about 11 miles southeast of Concord and is of interest as being the site of the first discovery of gold in North Carolina. In 1799 a 17-pound nugget was found and in 1803 one weighing 28 pounds. The placer deposits of the Reed mine have been very vigorously worked in former years and a considerable quantity of gold has been found. There are a number of other promising gold properties in this county, among which are the Nugget, Rock River, Buffalo, Phœnix, Furness, Tucker and Pioneer Mills mines, some of which have been more or less worked and developed during the past year.

Mecklenburg has been one of the most important and active counties in gold mining of any in the State. The mines are distributed over almost the entire county, with Charlotte as a center. The more important mines are the Davidson Hill (one mile west of Charlotte), Saint Catherine, Rudisil and Clark (2½ miles west of Charlotte), Palmer, Howe and Parks (1 mile northeast of Charlotte), Brawley

(4 miles west of Charlotte), Arlington (6 miles west of Charlotte), Capps, McGinn and Alexander (8 miles northwest of Charlotte), Dunn (7 miles northwest of Charlotte), Ferris and Ray (8 miles southeast of Charlotte), and Surface Hill (10 miles east of Charlotte).

The Rudisil mine, which is 1 mile south of Charlotte, is perhaps the best known. In the upper part of the mine the rock is a silicified, chloritic and argillaceous slate. At a depth of 200 feet this gives place to a crystalline eruptive rock. The ore bed consists of two parallel veins, close together and separated by a slate which varies in thickness from 2 to 6 feet. The maximum depth to which the mine has been worked is 300 feet. The mine carries very rich but highly sulphureted ores, and thus far but little attempt has been made at concentration or treatment of these sulphurets. Many of these mines will become producers when the custom smelter is able to handle their ores.

In Gaston county the principal mines are the Oliver and Farrar, which are about 12 miles northwest of Charlotte, the former of which is reported to have been worked by one of the early German settlers before the Revolutionary War; the Duffie, McLean, Long Creek and King's Mountain (or Catawba).

The King's Mountain (or Catawba) mine is situated about 1½ miles south of King's Mountain, a station on the Southern Railway, in the southwest corner of the county. The country rock is mica schist intercollated with lenticular layers of siliceous magnesian limestone. The ore beds are large lenticular chimneys or shoots of this limestone containing auriferous quartz and sulphurets. Five of these chimneys or lenses have been opened in this mine. The length of these lenses reach about 100 feet and in thickness they are about 20 feet, being separated from each other by the black graphitic slate. The mine has beeen worked to a depth of 320 feet.

The principal mining that has been done in the South Mountain gold region has been the hydraulicing and sluicing of the extensive placer deposits which are found in Burke, McDowell and Rutherford counties, and it has only been within the last few years that any attempt has been made to work the quartz veins. Many of the gold-

bearing quartz veins are too narrow to justify any deep mining, but there are some that have been found on a much larger scale that give promise of making profitable mines. The principal work now being done on these veins is a section 6 and 12 miles north of Morganton, where two types of gold deposits have been encountered, one in which the gold occurs in the quartz veins and the other where it occurs in bands of the country rock, either in the form of free gold or finely divided sulphurets. This district is perhaps attracting as much attention as any other at the present time and has within the past two years furnished some splendid gold ore during the development work. The principal mines in this South Mountain district are the Miller, Scott Hill, Pack's Hill, and Baker mines in Caldwell county; the Mill's property, Hancock, Hercules and Martha mines in Burke county; Cain Creek, Brackettown, Huntsville and Vein in McDowell county; and the Golden Valley in Rutherford county.

There has been a little gold mining in Cleveland county and in the vicinity of Columbus, Polk county.

West of the Blue Ridge there has been but little mining carried on for gold, and it has been principally the sluicing of the gravels in Cherokee county.

The total production of gold in North Carolina for 1901 was $60,410.71 (coining value) as compared with $44,653 in 1900. This is an increase of $15,757.71, which indicates the advance that is being made in gold mining in the State. In the table below are given the production of gold and silver by years from 1882 to 1901.

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA FROM 1882 TO 1901.*

YEAR.	GOLD.	SILVER.
1882	$ 190,000	$ 25,000
1883	167,000	3,000
1884	157,000	3,500
1885	152,000	3,000
1886	175,000	3,000
1887	225,000	5,000
1888	136,000	3,500
1889	145,000	3,878
1890	118,500	7,757
1891	95,000	6,465
1892	78,560	12,671
1893	53,600	17,325
1894	46,594	455
1895	54,200	520
1896	44,300	646
1897	34,600	388
1898	84,000	905
1899	34,500	388
1900	44,653	15,986
1901	60,410	34,023

While gold mining is at the present time but a small industry in North Carolina, when its production is considered, it is of considerable magnitude when the working capital invested in gold mines and properties is taken into consideration. The work that is now being carried on will result in the mines again becoming producers of gold in larger quantity than for the past twenty years.

SILVER.

There are mines in North Carolina that have been operated during 1901 exclusively for silver; but more or less silver is obtained in nearly all of the gold and copper mines, especially the latter. The copper mines at Gold Hill and in the Blue Wing district have produced most of the silver.

The principal silver mines are the Silver Hill, located 7 miles southeast of Lexington, Davidson county, and the Silver Valley, 5 miles northeast of the Silver Hill. These two mines have attracted a great deal of attention on account of the apparent richness of their

*Coining values are given.

ores, which are a complex mixture of galena, pyrite, sphalerite, chalcopyrite and quartz. The galena is rich in silver and near the upper surface of the Silver Hill, rich bunches of native silver were found, with the oxidized products of the primary sulphides. As the mining was carried deeper the unaltered sulphides were encountered and as the percentage of sphalerite (zinc blende) was high, mining became unprofitable. Pockets of pyrite were encountered that assayed over $200 in gold, while other portions of the pyrite only showed the presence of a trace of gold. Ores of this type are receiving the attention of metallurgists and it is not at all improbable but that these ores will in time be able to be worked profitably, if they occur in sufficient quantity.

The production of silver in 1901 was over twice that of the year before and amounted to $34,023.64 as compared with $15,986 in 1900, an increase of $18,037.64. This is the largest production that has been made for over 20 years. This large increase is partly due to the metal obtained from the copper ore of the Union copper mine at Gold Hill, and the larger production of copper ores in the Blue Wing district which contain some silver.

COPPER.

There has been a very material increase in the development and mining of the copper deposits of the State during 1901. The most important change in the copper situation is the addition to the list of producers of the mines of the Union Copper Mining Company at Gold Hill, Rowan county. The production has not only increased, but a number of mines have been thoroughly equipped and will become producers during 1902. Transportation facilities are greatly improved in the Blue Wing district and it is expected that the Ashe county deposits will soon have railroad connections.

The copper deposits of the State are for the most part in three distinct districts: the Virgilina or Blue Wing, which extends across Halifax county, Virginia, and Person and Granville counties, North Carolina; the Gold Hill of Rowan and Cabarrus counties; and the Ore Knob of Ashe county. Of these the first district has been the scene of the most development and the largest production.

Occurrence.

*Virgilina District.**—The Virgilina or Blue Wing district consists of an area 20 miles in length and 3 miles or more in width; the mines for the most part being located on a rather flat-topped ridge rising 100 to 200 feet above the level of the surrounding valley. The country rock of this area is mainly what is known locally as greenstone or slate, which varies in color from dark green to grayish black. It is in fact an igneous rock of an andesite type, which has been crushed and metamorphosed. The fissures formed have been filled with metallic sulphides and gangue and are the veins that are now being worked and prospected. These fissure veins are dipping uniformly toward the east and have a strike nearly north and south (the general strike of the rocks being nearly 15 degrees east), and are approximately parallel to each other. They are sometimes cutting across the country rock and at other times are parallel to its schistosity. They vary in width from 2 to 15 feet, but the general average of those that are being most extensively worked are from 5 to 6 feet wide. Alteration of these ore deposits has extended to a depth of 25 to 40 feet and in some of the openings considerable malachite (green copper carbonate) is obtained. This alteration has not resulted in the formation of gossan, as this is usually understood, and the veins are comparatively firm and solid from the surface. There is some azurite (blue carbonate of copper) and cuprite (red oxide of copper) found in this zone of oxidation products and also rarely a little native copper. As the sulphide ores are encountered they are found to consist for the most part of chalcocite (gray copper or copper glance) and bornite (peacock copper). A very little chalcopyrite (copper pyrites or yellow copper) has been found along the western limits of the copper area. The gangue consists principally of quartz with some epidote, hematite and sparingly calcite. Gold and silver are also found in these ores in limited amount. The chalcocite ores are for the most part confined to the deposits in Person county and the bornite ores to those in Granville.

These veins are not found with a uniform width, but are all lenticular, although the largest veins have a continuous outcrop for a

*Am. Inst. Min. Eng.; Eng. and Min. Jour.

mile or more, and the underground workings show the vein to be continuous. They are, however, lenticular in form, widening and pinching both vertically and horizontally. This is the more noticeable in the smaller veins where the lenses of ore and quartz are connected with each other by simply a thin seam of quartz, which sometimes is lacking so that the vein has the appearance of giving out. These have been formed in part by the simple irregular fracturing of the metamorphosed schists, with a subsequent faulting, amounting to but a very few feet, which have produced the lenticular spaces that are now filled with quartz and ore, and calcite and ore. In some instances the faulting was complex and the result is a banded structure in the ore deposits, there being a succession of small seams or plates of the schist in the quartz gangue.

The most prominent mine of the district is the Holloway, 4 miles southwest of Virgilina, Va., on a spur of the Southern Railroad, and is owned by W. E. C. Eustis of Boston, Massachusetts. This is the most extensively developed mine in the district, and, while it represents a private enterprise, it is one of the most successful mining plants in the State. The mine has been worked to a depth of about 400 feet and the output shipped to a smelter at Norfolk, Virginia. The mine has been developed by four levels which have been run both north and south of the shaft for 100 feet at depths of 75, 150, 200 and 300 feet respectively. This work has shown the vein to vary greatly in width, being from 3 feet to about 100, and also illustrates the lenticular structure of the veins of this district, already referred to. The general trend of this Holloway vein is N. 15° to 20° E. With the present equipment of the mine, the output is about 50 tons of ore per day which is concentrated by hand-picking and cobbing to about one-half, which is shipped, the remainder being piled up awaiting some other means of concentration. This ore, which is more or less siliceous, is used to advantage at the smelter for fluxing with other ores low in silica.

The Blue Wing mine, formerly owned by the Boston and Carolina Copper Mining Company, and now controlled by Mr. John T. Williams of New York, is two miles south of Virgilina and was one of the first mines in this district to be developed. The mine is being

thoroughly equipped and put in shape for shipping high grade concentrates. The ore deposit differs materially from the others of the district and is a splendid example of the complex fissure vein referred to above. The mine has been developed by means of a shaft that is about 180 feet deep with drifts running from the 100 and 150-foot levels. At the 100-foot level the drift extends 348 feet north and 115 feet south of the shaft and shows the vein to be nearly constant, 3 feet in width. From this level to the surface the ore has been pretty thoroughly stoped out. The ore consists of bornite in a gangue of quartz and calcite.

The mines of the Person Consolidated Copper and Gold Mining Company, 8 miles south of Virgilina, are on the same vein as the Holloway, but near the southern end of the belt. The two principal mines of the company are the Yancey and Durgy, the former being one of the oldest mines of the district. Several thousand tons of ore are on the dumps that was taken out during the development work of last year. The company are preparing to erect a concentrating mill of 50 to 75 tons capacity and it is confidently expected that copper concentrates will begin to be shipped during 1902.

The Arringdale mine is 7 miles a little west of south of Virgilina and the Morong 3½ miles south. Both of these mines are being developed by means of shafts and drifts, and are giving very encouraging results. Other mines that are being developed in the district are the Copper World, Warlick and Tingen mines. This district has now very much the appearance of a permanent and prosperous mining camp. All these ores contain more or less silver.

Gold Hill District.—The Gold Hill district is 14 miles southeast of Salisbury, beginning in the southeast corner of Rowan county and extending over into Cabarrus, a distance of 12 miles or more. The country rocks are chloritic and argillaceous schists and slates, striking about N. 25° to 30° E. and dipping 75° to 80° N. W. On the west of these schists there is an intrusive mass of granite and on the east metamorphosed dioritic rocks. The ore bodies consist of certain portions or bands of the schists or slates that are impregnated with auriferous pyrite and chalcopyrite and of imperfectly conformable lenticular lenses and stringers of quartz con-

taining these sulphides. These have in some cases been successfully worked for gold. The principal mine in this district is that of the Union Copper Company, who have thoroughly equipped their mine with all modern machinery for mining and hoisting the ore and have erected a large concentrating plant and smelter. The mine is about 14 miles southeast of Salisbury and three miles from Gold Hill depot, which is on the Southern Railway, but is connected by a spur with this line. There has been expended in the neighborhood of $1,000,000 in the development of this property and the erection of buildings, etc., and this mine has become during 1901 one of the producers of copper.

The ore deposit has been developed by means of 12 shafts of varying depths, the deepest one being 800 feet. The ore consists principally of chalcopyrite, with occasionally a little bornite and pyrite, in a gangue of quartz. The mine is being worked by means of a vertical shaft 520 feet deep which is connected with a 430-foot inclined shaft; and by two separate vertical shafts, one 305 feet deep and the other 225 deep. Besides these working shafts there are 8 shafts ranging from 150 to 200 feet that were sunk during the development of the mine. The ore carries, besides copper, considerable values in gold and silver. The ore, as it comes from the mine, is sorted and the lower grades crushed and rolled and then concentrated. The concentrates, together with the selected ore, are roasted and then smelted to a matte containing 50 per cent. of copper and the gold and silver. This matte is shipped north for refinement.

Another mine in the Gold Hill district or belt is the Cruse mine, which is in Cabarrus county, about 10 miles northeast from Concord, the county-seat, and 12 miles nearly south from Gold Hill. Concord is the nearest railroad station. The ore occurs in a series of quartz lenses, having a width of from 1 to 3 feet and dipping about 555° to the east, but pitching a little toward the northwest. These lenses all have fairly sharp boundaries and in some cases are entirely separated from each other, while at other times they are connected by thin stringers of quartz. Their general strike is N. 35° W. and they can be traced almost continuously for about 600 feet. The vein has been developed by means of three shafts, 140

feet, 40 feet and 35 feet respectively in depth and by a number of small pits. The 140-foot shaft was in ore the whole distance, the vein varying in width from 15 to 30 inches. At a depth of 75 feet a drift was run 20 feet to the southeast, which showed the vein to practically pinch out in that direction. At the bottom of the shaft another drift was run to the southeast, which also showed the vein to nearly pinch out. Toward the northwest, however, as far as the work has been continued, which was 15 or 20 feet, the vein holds its own width. Hugging the foot wall at the bottom of the shaft was a seam of nearly pure chalcopyrite from 3 to 4 inches in width and this has been nearly continuous throughout the whole depth of the shaft. The rest of the vein had the chalcopyrite scattered sparingly through it in small bunches and particles. The other vein minerals were siderite (iron carbonate), which occurred in considerable quantity, hematite and pyrite in a gangue of quartz. Particles of chalcopyrite were also observed impregnating the country rock in some places for a distance of 7 feet from the vein. For a few feet each side of the vein, the wall rock is more or less impregnated with small seams and stringers of quartz that are apparently following the schistosity. The other two shafts encountered similar lenses f ore.

There are a number of other copper mines and properties in the vicinity of Gold Hill and Salibsury, as the Conrad Hill mine, 6 miles southeast of Lexington; the Gold Knob, 9 miles, and the Reimer, 6 miles southeast of Salisbury on the Yadkin river; and the Bullion, one-half a mile east of the Reimer. These properties should be able to be worked, if favorable railroad rates can be obtained for shipping their ore to the smelter of the Union Copper Company at Gold Hill. Many of these ores carry good values in gold and silver.

Ore Knob District.—In the Ore Knob district the principal mines are the Elk Creek, Copper Knob, and Ore Knob. Of these the Ore Knob mine was successfully worked as long as the oxidized products lasted. This Ore Knob mine is situated near New river, Ashe county. The ore deposit is a fissure vein with a strike N. 60° E., cutting the gneisses and mica schists comprising the country rock. The vein is from 6 to 14 feet wide and has been altered to a depth of about 40 to 70 feet. A strong iron goasan is encountered, be-

neath which, and between it and the sulphides, is an iron-black, friable and crystalline ore, carrying as high as 36 per cent. of copper. This ore is from 20 to 30 feet deep when the sulphide ores were encountered, which consisted of chalcopyrite with magnetite, pyrrhotite, and pyrite in quartz. This property is now being developed by the Garretson Southern Furnace Company, who are erecting a smelter and reduction works and expect to become producers of copper during 1902. The property has been developed by means of 8 shafts aggregating 854 feet and by 1,276 feet of levels. It has been estimated by the company that they have 150,000 tons of a 2 per cent. ore lying on the dumps.

The Peach Bottom Copper Company are developing the Elk Creek or Elk Knob mine on Elk creek, Alleghany county, by means of two shafts, one 140 feet and the other 170 feet in depth. The ore deposits are similar to those of Ore Knob and the work that has been done in this district shows ores to be in quantity, but of low grade.

In Jackson county there has been some development work carried on by the Cullowhee Copper Company at Forest Hill, near Cullowhee. In Swain county the Everett Mining Company has done some extensive development work on the copper property at Hazel creek near Medlin, and are erecting a smelter. Sufficient work has not as yet been done at either of these properties to actually determine their value. The ores are chalcopyrite. In Crab Orchard township, Mecklenburg county, the Vista Copper mine is being developed with some success. In Chatham county, about 2 miles southeast of Harpers Cross Roads on the Nat Phillips farm, some prospecting and development work has been done in 1901. One shaft 80 feet deep has been sunk which encountered a 12-inch seam of chalcocite (gray copper) ore at the surface which widened to over 3 feet at the bottom.

The custom smelter of the Union Copper Company at Gold Hill and the proposed one of the Blue Wing district will be of material advantage to the development of copper properties in their respective vicinities. With the price of copper at 12 cents per pound,

as it was at the beginning of 1902, there must be the more favorable conditions for mining and smelting of the ore; but even at this price, copper mining should be a good, profitable industry in the State. This reduction in price of copper does not mean a less demand, for this is constantly increasing, but with the increased number of producing mines and the fact that a number of the large users of copper are also now miners of this metal, it is not at all improbable but that the price will remain in the neighborhood of 12 cents per pound for some time to come.

During 1901 there were 10,398 tons of copper ore mined which were valued at $76,900 as compared with 6,948 tons valued at $41,600 in 1900. This is a decided increase in the production and is largely due to the Gold Hill district. Considering the amount of substantial work that is being done at the different copper mines, the production should be greatly increased in 1902.

IRON.*

The iron ores are very widely distributed over the State and include magnetite (the magnetic oxide of iron), hematite (the red oxide), limonite (the yellow oxide), and bog iron ores. Siderite or spathic iron occurs sparingly at a number of iron mines.

On account of the low prices of iron, many points have to be carefully considered regarding the ore in order to determine whether it can be profitably mined; and these are its chemical composition, mechanical structure, proximity to a supply of fuel, flux and water, and relation of the cost to the market price.

The first is by far the most important, for the first thing to determine is what percentage of iron the ore will carry, and how free it is from the injurious elements, sulphur, phosphorous, and titanium. There are a number of minerals that contain a high percentage of iron that will not make profitable iron ores, and very high percentage of iron in a mineral deposit does not necessarily mean a good iron ore. Many attempts have been made to use the titanic iron ores, but they have resulted in complete failure and loss. The titanic acid of the ore passes into the slag, making it very difficult of fusion, and 1 per cent. of titanic acid in the ore will condemn it. Sulphur is injurious

*See also Bulletin 1, 1893, N. C. Geol. Survey, Iron ores of N. C.

in an ore, for it cannot all be eliminated from the pig-iron, and renders it red-short, that is, brittle when hot; and phosphorous goes pertially into the pig-iron, making it cold-short, that is, brittle when cold. Nearly all of the iron ores in North Carolina are low in sulphur, while those carrying titanium are usually confined to the magnetic ores.

The mechanical structure of the ore is also important, for the value of the iron increases or decreases according to the amount of gangue removed in mining the ore, and also the amount of cleaning that is necessary before the iron is ready for smelting, and the amount of foreign material that has to pass through the furnace. It is often of serious importance to determine whether it is cheaper to smelt the ore where it is mined or transport it to a furnace erected near the source of fuel and flux.

The history of iron mining in North Carolina dates back to as early as 1729, when small shipments of iron were made to England. The ore first mined was probably the bog ores near the coast. Mining for iron almost kept pace with the settlement of the western portion of the State. The remains of the old workings are still visible, but they do not indicate that because they have been worked there is a quantity of ore, or because they have been closed, the ore gave out. They would all have to be examined to prove them one way or the other.

Some of the principal iron localities are: The magnetite ores of Granville, Stokes, Surry, Catawba, Ashe and Mitchell counties; the limonite ores of Chatham, Gaston and Cherokee counties; and the hematite ores of Granville county, these being confined principally to the Piedmont Plateau and Mountain regions. Geologically, the magnetites and hematites are confined almost exclusively to the crystalline rocks. Some limonites are also found in these rocks as well as in the Ocoee formation of Madison and Cherokee counties. Limonite ores (bog-iron ores) are also found in the more recent formations of the Costal Plain region.

The most noted iron mine in the State is the magnetite iron mine at Cranberry, Mitchell county, which is at the terminus of the East Tennessee and Western North Carolina Railroad. The ore body consists of an immense lens of magnetite that has associated with it

hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. The ore is distributed in irregular masses through the gangue and at times intimately associated with the same in thin bands. The thickness and extent of these bands are variable, from a few inches to more than fifty feet.

Nearly all the iron produced in 1901 was from this mine, and amounted to 2,578 tons valued at $4,997, as compared with a production of 21,000 tons in 1900 valued at $42,000. The Cranberry mine was not operated for the greater part of the year, the time being spent in development work and improvements to the plant. It is expected that in 1902 there will be a constant output per month that will make the total production for the year greater than that of 1900. The other mine producing iron in 1901 was the Potato creek mine, located in the Piney Creek district, Alleghany county, and contains magnetic ore.

The large iron deposits in Ashe county are reported to have been purchased by the Pennsylvania Iron Company, who contemplate beginning extensive operations in the near future.

The shutting down of the large blast furnace of the Empire Steel and Iron Company at Greensboro has been the cause of the closing down of the mines in the eastern and central part of the State. It is reported on good authority that this furnace will again be in operation before the end of 1902.

While at the present time the iron ores of the State are adding but little to its wealth, yet they do represent reserved sources of wealth that will in time be available. The competition with the Lake Superior iron ores that has effectually closed the North Carolina mines is not permanent, for their deposits are limited in extent, and unless new sources of supply are found in the immediate vicinity, other known iron ores will become available.

MANGANESE.

While there has been but a few sample car loads of manganese ore shipped from the State, there has been considerable prospecting for this ore. The principal work has been done near Brevard, Tran-

sylvania county; Canton, Haywood county; and near Goldsboro, Wayne county. While as yet no large deposit has been definitely located, these three are promising occurrences.

The deposit in Transylvania county is about 7 miles northeast of Brevard and 3½ miles from Blantyre, a station on the Transylvania Railroad. The deposit has been developed by means of 7 shafts along the strike of the vein in a distance of 2,000 feet; and near one shaft the vein was exposed for 200 feet. The deposit has been estimated to be 18 feet wide, and is capped for a distance of 10 feet by limonite, which does not carry more than a trace of manganese oxide. Below this point the manganese oxides begin to come in, with the iron minerals predominating in the ratio of 5 to 1. These are so arranged, however, that the limonite is readily eliminated by hand-cobbing. The strike of the vein is in a general N. E.-S. W. direction, and it is dipping toward the east. Assays of this ore show it to vary from 22 to 57 per cent. of manganese, these representing two samples, one which was considered the poorest ore encountered and the other the best. An average sample of the ore, after cobbing to eliminate the yellow limonite, will contain from 45 to 50 per cent. of manganese.

Six samples representing various types of ore from this deposit gave the following results when analyzed:

ANALYSIS OF MANGANESE ORE FROM NEAR BREVARD.

	Iron (Fe).	Phosphorus (P).	Silicon (Si).	Manganese (Mn).
1	16.01	.037	1.56	43.93
2	3.26	.071	.39	57.02
3	13.44	.109	.93	45.08
4	32.37	.207	3.32	22.54
5	5.68	.227	1.34	48.66
6	32.02	.505	1.25	25.34

Samples 1, 2, 3 and 5 all show a high per cent. of manganese, and with the exception of No. 5 are low in phosporous and silicon. The portions of the ore deposit that are like Nos. 4 and 6 can be as a rule readily eliminated, so that the manganese contents of the commercial ore are kept high.

This is one of the more promising manganese properties in the State and has been developed by Mr. Robert Harris of Franklin, North Carolina.

The Haywood county deposit is located in Beaver Dam township, two miles southwest of Canton, on land of J. B. Rhodarmer and S. W. Smathers of Canton. Manganese ore has been found as float pieces over an area of about 300 feet wide and nearly a quarter of a mile in length, starting from a flat near the tobacco barn (west of the house) and extending in a northeast direction. The better samples of ore have been found nearer the southwest end. The only development work that has been done is a small cut in bank of road and parallel to it, about 40 feet long, which exposed a number of streaks of manganese ore, covering not over one-sixth of the exposed surface. At the west end of this cut a shallow pit 4 feet deep showed the streaks of ore to increase in width.

Only a very small percentage of the ore exposed is hard and compact and this was found mostly in the pit. Most of the ore is soft and friable and considerable of it is mixed with limonite. Near the northeast boundary of where float ore has been found, a streak of limonite mixed with manganese oxide was observed in the bed of a brook. This point is thirty or more feet higher than the cut and the manganese ore is overlaid by a blueish pipe clay.

Assays were made of this ore as follows: 1, of the hard compact ore from open cut; 2, soft friable ore from cut; 3, ore mixed with limonite; 4, ore from northeast boundary.

	PER CENT. MANGANESE.
1	51.93
2	3.77
3	3.55
4	10.80

Near Goldsboro, Wayne county, a deposit of manganese is being investigated by Mr. S. G. Fry of Goldsboro. The ore on the surface has been assayed and gave the following results:

	PER CENT. MANGANESE.
Compact black ore	13.4
Pink silicate	17.9

Many of the black masses of ore when broken open were found to contain this pink mineral, which fuses readily before the blow-pipe, to a black magnetic bead. A complete analysis was made of this mineral with the following results:

ANALYSIS OF SPESSARTITE FROM NEAR GOLDSBORO, NORTH CAROLINA.

Specific gravity, 4,041.	PER CENT.
SiO_2	38.86
Al_2O_3	19.86
FeO	13.81
TiO_2	.52
P_2O_5	.39
MnO	20.16
CaO	4.27
MgO	2.24
H_2O	.36

This analysis shows the mineral to be spessartite, the manganese garnet.

It is not at all improbable but that as these properties are developed the manganese ore will be found to exist in quantity.

The value of a manganese ore varies with its percentage of this metal, and to be readily marketable it must contain at least 40 per cent., and be low in phosporous. The price of these ores quoted at New York is $ per ton for a 50 per cent. ore; for every unit (per cent.) less than this the value decreases; but for every unit above 50 per cent. there is a corresponding increase in the value of the ore.

PYRITE.

The mineral pyrite, a sulphide of iron (FeS_2) has been mined for the manufacture of sulphuric acid. The principal deposit is the Oliver mine, 4 miles from Crouse, Gaston county. This mine has recently been purchased by the Virginia-Carolina Chemical Company and it is very probable that the mine will not be operated for the present.

Near Toxaway, Transylvania county, a deposit of pyrite has been found by Dr. W. C. Fisher which gives indications of containing this mineral in quantity.

As a by-product in gold mining, the sulphuret concentrates, which are too low in gold to be treated either by the cyanide or chlorination process, offer a possibility of being profitably used for the manufacture of sulphuric acid. This is the intention of the Whitney Reduction Company of Gold Hill, who will have a large quantity of sulphurets which are too low in gold to be of value for the extraction of this metal.

The production of pyrite in 1901 was 4,000 tons valued at $32,000, while in 1900 the production was 4,500 tons valued at $14,625. This increase in the value of the ore was due to its higher percentage of sulphur.

CORUNDUM.

Corundum is a mineral that was formerly supposed to occur but sparingly in nature, but is now known to be quite wide in its occurrence. It has been found in North Carolina associated with peridotite, pyroxenite, amphibolite, anorthosite, serpentine, gneiss, mica-schist, quartz-schist, amphibole-schist and chlorite-schist. Of all these the most common occurrence is corundum in peridotite, During 1901 corundum deposits were mined which occurred in peridotite, quartz-schist and chlorite-schist. In recent years attempts have also been made to mine corundum in amphibolite, gneiss and amphibole-schist, but in every instance they could not be successfully operated either on account of the low percentage of corundum in the rock, or on account of the refractory nature of the rock, or the erratic occurrence of the corundum, which in a number of instances gave out entirely. In a few instances where the corundum occurred in the decomposed portion of the rock so that it could be separated by sluicing they were successfully worked, but as soon as the hard rock was encountered the mine had to shut down.

There are three names in constant use to designate the varieties of corundum: 1. Sapphire, which includes all of those corundums that are transparent to semi-transparent, of whatever color; 2. Corundum, including the translucent to opaque, of all colors; 3. Emery, which is a mechanical admixture of corundum and magnetite or hematite. The last two varieties are those used in the arts, for abrasive purposes; the emery being used in very much larger quantity than the corundum. It is of course the presence of corundum in the emery that gives it

its abrasive qualities and makes it of commercial value, and the abrasive efficiency of the emeries will vary according to their percentage of corundum.

Any corundum that is transparent is brought under the head of sapphire, although many of these have distinct names in the gem trade. These are taken up under the head of gems. The corundum gem or sapphire localities are usually distinct from those of corundum, although some very handsome gems have been found in some of the mines where corundum was mined for abrasive purposes, notably the Corundum Hill, at Cullasaja, Macon county.

Occurrence.

Corundum, as it is mined for abrasive purposes, occurs as sand, crystal or gravel, and block corundum, sometimes all three types being found in the same deposit. The sand corundum consists of small grains, crystals or fragments of mineral scattered through the vein. The crystal corundum consists of crystals up to three inches in length. Often these crystals have parting planes so thoroughly developed that they often cause the corundum in crushing to break up into regular rhombohedrons, this continuing even to the finer sizes, which causes the grains to break down when in use. This continued regular breaking destroys the cutting efficiency, which is dependent on its irregular fracture, which produces the best cutting edge. The block corundum often occurs in masses from ten to a thousand pounds in weight of almost pure corundum. Then again, it occurs in large masses intimately associated with hornblende, feldspar, etc., making a very tough and difficult rock to work. Often the only way to break these masses is to build fires over them and then to suddenly cool them by pouring water upon them. The parting planes are at times very noticeable in the block corundum and are detrimental to the commercial product in the same way as to the crystal corundum.

There is a constant demand for corundum, more at the present time than is being supplied, and this has caused more thorough prospecting to be undertaken for this mineral. Although there are over 60 localities known in North Carolina where corundum occurs, which extend over a considerable portion of the western part of

the State, it is at present only known to occur in commercial quantity in the four counties, Clay, Macon, Jackson and Transylvania. These corundum deposits are unquestionably of great economic importance to the State, and considering the energy with which the industry is now being pushed, it will be but a short time when the corundum will be bringing a considerable income into the State. The principal mines are the Corundum Hill at Cullasaja and the Mincey at Ellijay, Macon county, the Buck Creek or Cullakeenee, Clay county; the Socrates, Bad Creek, and White Water near Sapphire, Jackson county; and the Burnt Rock and Brockton in Transylvania county, the corundum at all these being associated with peridotites; the Scaly mountain in Clay county, where the corundum is associated with quartz schist; and the Caney Creek mine in Jackson county, where the corundum occurs in a chlorite schist. Besides these, there are a number of other deposits that are being developed and others that are promising prospects, as the property of the North Carolina Corundum Company on Little Buck creek, Clay county; the Gray and Robinson properties on Ellijay creek, Macon county; a deposit in Woodfin Cove, Balsam Mountain, near Hall, Jackson county; the Corbin and Grimshawe properties near Montvale, Transylvania county; and the Carter mine, Madison county, near Democrat, Buncombe county.

The only mines that have produced any quantity of corundum during the past year are: The Corundum Hill mine at Cullasaja, Macon county, whose production has been smaller than usual, and which after being cleaned was shipped to Chester, Massachusetts, where it was sized and prepared for market; the Scaly mountain mine in Clay county, which has for the first time produced corundum for the market, it being cleaned and sized at the mine; and the Caney Creek mine, Jackson county.

The North Carolina Corundum Company have done considerable development work on their property at Little Buck creek, Clay county, and they report very encouraging results regarding the amount of corundum exposed. The Toxaway Company, who own most of the mines in the vicinity of Sapphire, Jackson county, have done a little work on their corundum deposits, sufficient, however, to expose the corundum at the Brockton mine and on the Corbin

property. The National Abrasive Manufacturing Company own the corundum deposit on Caney creek, Jackson county, where the corundum occurs in a mica and chlorite-schist, and the work that they have done here, while not actually demonstrating the quantity of corundum, does show that it is of good quality, and that it will make a good wheel.

Uses.

The uses of corundum are very limited and can be divided into two general heads—gems and abrasives.

Both corundum and emery are used in the manufacture of abrasive materials, and these are on the market in three forms—as wheels and blocks of various shapes and sizes; as emery paper; and as the grains or powder. The last two need no further explanation.

The shapes of the corundum and emery wheels and bricks, or stones, are very varied, being adapted to all kinds of grinding. The principle of these wheels is the same as that of the rotary file, and as the points of a file become dull from using, so also do the grains or points of the emery and corundum in the wheel. It is necessary, therefore, in making a wheel that it be made of such a temper or grade that when these grains become dull or rounded they will fall away or will be readily removed by a truing tool, leaving fresh sharp ones exposed. The grade of a wheel depends upon the character of the work for which it is to be used, and the bond should be such that it will wear away a little faster than the emery or corundum, and thereby always leave the sharp edges ready for cutting. The greatest economy results when the bond does not wear away until the grains of emery or corundum have become rounded and dulled.

There are three types of wheels known to the trade—the vitrified, chemical, and cement—the names being derived from the processes by which they are manufactured. In the manufacture of all of them the corundum or emery used is in grains of uniform size, but these vary with the grade of wheel to be made. The vitrified wheel is the most important and the one more generally used, although for some work one of the others is often preferable, and for the manufacture of very large ones the commercial wheel is especially adapted.

Where formerly North Carolina and Georgia were the only States that were producing corundum, and all the deposits were occurring in peridotite, this mineral is now being mined in Ontario, Canada, and in Montana, where the mineral occurs in syenite, and the former mine is shipping considerable quanitites of this mineral into the United States. The Montana mines expect to put corundum on the market during 1902. These two deposits will be strong competitors of North Carolina corundum, but there should be no difficulty for the North Carolina deposits to compete with them, for the corundum is as good quality. While the market for corundum is a limited one, and there could be easily an oversupply, yet with a reduction in price for this mineral, there would be a correspondingly increase in the demand, which would be at the expense of emery. The artificial abrasives, carborundum and artificial corundum, are competitors of corundum and this is especially true with corundum at its present price. There has been a constantly increasing demand for abrasives and there will continue to be an increase just so long as our manufacturing industries continue to grow. There will be changes in the abrasive industry, but it will not be in a reduction of the production of abrasives, but in the kind of abrasives that will be used. As corundum has the highest abrasive efficiency of all the natural abrasives, it will be more in demand, if the price can be kept sufficiently low.

In 1901 the production of corundum was 325 tons valued at $48,840, which is an increase of 120 tons and of $12,000 in value over that of 1900, the production of which was 205 tons valued at $36,840. This increase is due principally to the production of the Scaly Mountain mine. With, however, the amount of this mineral that is known to exist in the State and the demand that there is for it, there should be five times this amount produced.

GARNET.

The name garnet is used to designate a group of minerals which have many identical and similar physical properties and similar chemical properties. They all crystallize in the isometric system, with the dodecahedron and trapezohedron as the common forms.

They vary in specific gravity and color according to their chemical composition. The different minerals that have been identified as belonging to the garnet group are given in the following table, together with their chemical composition, specific gravity and hardness:

LIST OF GARNETS.

Garnet.	Chemical Composition.	Specific Gravity.	Hardness.
Grossularite (Calcium—aluminum garnet)	$Ca_3Al_2Si_3O_{12}$	3.55—3.66	6.5—7.5
Pyrope (Magnesium—aluminum garnet)	$Mg_3Al_2Si_3O_{12}$	3.6 —3.7	6.5—7.5
Almandite (Iron—aluminum garnet)	$Fe_3Al_2Si_3O_{12}$	4. —4.15	7. —7.5
Rhodolite (Magnesium—iron—aluminum garnet)	$2Mg_3Al_2Si_3O_{12}$ / $Fe_3Al_2Si_3O_{12}$	3.83	7.5
Spessartite (Manganese—aluminum garnet),	$Mn_3Al_2Si_3O_{12}$	4.2	7. —7.5
Andradite (Calcium—iron garnet)	$Ca_3Fe_2Si_3O_{12}$	3.8 —3.9	7.
Uvarovite (Calcium—chromium garnet)	$Ca_3Cr_2Si_3O_{12}$	3.41—3 52	7.5

Of the above garnets, those that are used as abrasives are pyrope, almandite and andradite. In the above table the theoretical composition is given for the different varieties, but they will be found to vary, as ferrous iron, calcium, magnesium and manganese are isormorphous with each other and are capable of replacing each other, which is also the case with ferric iron and aluminum. As is seen, the hardness of the different garnets varies from 6.5 to 7.5. The uses of garnet are in the manufacture of sand-paper or "garnet paper" which is used extensively by boot and shoe manufacturers; and in the manufacture of abrasive wheels which are sold as emery or corundum wheels. Practically all the garnet mined in North Carolina is used for this latter purpose, and is the almandite variety. Its abrasive efficiency is good, and for some kinds of grinding it is especially adapted, but on account of its low fusibility, it cannot be used in the manufacture of the vitrified wheel. Garnets are also used as gems, and these are described beyond.

Garnet is one of the most widely distributed minerals and is found in many of the crystalline rocks. It is commonly associated with mica (muscovite) in pegmatitic dikes, although sometimes but sparingly; and often occurs abundantly in gneisses and schists. Bands

of these rocks often contain a large percentage of garnet while the enclosing rock contains practically none; and it is the occurrences in these bands that constitute for the most part the commercial sources of this mineral.

There are a number of localities in North Carolina that have been worked for garnet with considerable success. For the most part the occurrences are similar, being bands of garnetiferous-gneiss in ordinary gneiss, which are up to 50 or more feet in width and some of which average 30 per cent. of garnet.

The principal deposits are in Jackson county, one, the Sugar Loaf mine, being near the summit of Sugar Loaf Mountain, 1½ miles from Hall, a station on the Murphy branch of the Southern Railroad. Another, the Savannah mine, is on the head-waters of Betty creek on the east slopes of the Cowee mountains. The third is the Presley near Speedwell in the upper Tuckaseegee valley, about 12 miles from Sylva on the Southern Railroad. The garnet at all three of these localities is the almandite variety and some of it has been sold under the name of ruby corundum. On the slopes of Scaly Mountain in Clay county, there are bands of quartz-schist that are corundum and garnet-bearing, which are being mined for corundum and the garnet is saved as a by-product. About 5 miles west of Spruce Pine, Mitchell county, near the Burnsville road, there is a large deposit of massive garnet that occurs in pockets in a geissic rock. Associated with this garnet there is considerable epidote. At the present time its distance, 25 miles from the railroad, prevents its being an available source of garnet. With, however, the completion of the railroad that is now being built through Yancey and Mitchell counties, these deposits may prove to be of some considerable commercial value.

The principal production of garnet for abrasive purposes during the past two years has been confined to Jackson county and the two mines that have been worked exclusively for this mineral are the Sugar Loaf and the Presley. A small amount of garnet has been produced in 1901 as a by-product from the corundum mine on Scaly mountain, Clay county. The total production of garnet in 1901 was 775 tons valued at $43,000 as compared with 300 tons valued at $18,000 in 1900.

The plant at the Sugar Loaf mine is being increased and the production of garnet in 1902 will very probably be much larger than in 1901.

MICA.

Occurrence.

It is the varieties of mica known as muscovite and phlogopite to which all the commercial mica belongs, and in North Carolina it is the muscovite mica that is commonly found. It is very widely distributed, being a component of many of the crystalline and sedimentary rocks. When, however, it occurs in blocks or masses which can be split into sheets an inch or more in diameter, it has a commercial value which increases with the size of the cut sheets and these vary from 1x1 to 8x10 inches. These deposits of commercial mica occur for the most part in pegmatitic dikes or veins which are found in granite and in hornblende and mica gneisses and schists. These dikes or veins, which vary in thickness from a few inches to several hundred feet, are often very irregular and have arms or "veinlets" branching off from them in many directions. At times they are parallel to the bedding or schistosity of the gneiss or schist and again they break across this at varying angles; both of these phenomenon often being observed in the same dike.

In character these pegmatitic dikes are very similar to a granite and sometimes they are called "coarse granite"; and if we could conceive of the constituents of the granite being magnified a hundred times or more, we would have an appearance that would be very similar to a pegmatitic dike. These dikes consist of quartz, feldspar and muscovite-mica in varying proportions. In some portions of the dike or vein the quartz and feldspar are nearly equally distributed, while in others sometimes one and again the other will predominate. Feldspar has been observed that has crystallized out in masses of more than a ton in weight, and well developed crystals of this mineral have been observed that were 3x11½ feet. Sometimes the feldspar, quartz and mica have separated out in rather small masses while at others they are separated out on a much larger scale. As far as I have observed the occurrence of mica, the veins that yield the best com-

mercial mica are those in which the three minerals have crystallized out in the larger masses. Where the feldspar and quartz are rather small, the mica is apt to be small and often is of poor quality. All the mica veins do not carry commercial mica, and usually the dikes two feet and less in width are barren of mica that would have a commercial value. Still, on the other hand, all the wide veins do not carry a mica that would make profitable mining, for in some, the mica is in such small crystals and blocks, that sheets cannot be cut over an inch or two in diameter.

Regarding the mica itself as it occurs in the vein, it is usually in rough crystals called blocks or books, distributed sometimes nearly evenly in the vein and at others nearer the contact of the vein with the country rock. These blocks of mica are sometimes nearly perfect in their crystalline form which is monoclinic, but rhombic or hexagonal in outline. While these blocks usually vary in thickness from 3 to 15 inches in diameter and 1 to 18 inches in thickness, they have been found as much as four feet in diameter. These blocks have at times been converted into what is called ruled mica, the mica being cut into narrow strips whose edges are parallel to the intersection of the prism and base edges of the crystal, or "A" mica, where the sheets are striated on two adjacent edges. The percentage of mica in these pegmatitic dikes will seldom, if ever, average over 10 per cent. of the contents of the dike and it will sometimes not be over 1 per cent. Often the dike will have the apparance of containing a very much larger percentage, on account of a number of blocks of mica being clustered together in bunches and almost touching one another; while in other portions of this same dike, there may be an absence of mica for a distance of from 5 to 20 feet and thus the general average of mica in the dike will correspond to 1 to 10 per cent.

The principal deposits of mica in North Carolina are in Mitchell, Yancey, Jackson, Haywood and Macon counties, the two former having the larger proportion. In Mitchell county there are 66 and in Yancey 45 mines. These mines have been worked for the most part by crude methods, but even under these conditions, the Clarissa, Sinkhole, Hawk, Double Head, Spread Eagle, Deake and Cloudland mines in Mitchell county; the Ray mine in Yancey county; the Big

Ridge and Shiny mines in Haywood county; and the Iola, Burningtown, and Raby mines in Macon county have produced collectively considerably more than a million dollars worth of mica, and it is not unreasonable to suppose that under more favorable conditions the supply will be greater than what it has been in the past. Many of these old mines are now being reopened and worked with considerable success. North Carolina mica is still, as it always has been, superior to any other in the world.

Associated Minerals.

There are a number of minerals that occur associated with the mica in these pegmatitic dikes, some of which have a commercial value, principally as gems, and these are taken up on page 50. Below is given a list of the minerals that have been found in these pegmatitic dikes and those marked with an asterisk have been obtained in sufficient quantity to be of value commercially.

LIST OF MINERALS FOUND IN THE PEGMATITIC DIKES OF NORTH CAROLINA.

Quartz* (massive, crystallized, and smoky).		Magnetite.
Albite.*	Feldspars.	Gahnite.
Oligoclase.		Hematite.
Orthoclase.*		Menaccanite.
Microline.*		Limonite.
Kaolin.*		Rutile.
Muscovite.*	Micas.	Opal (var. hyalite).
Bootite.		Pyrite.
Beryl* (emerald, yellow and aquamarine).		Molybdenite.
Almandite.	Garnets.	Pyrrhotite.
Andradite.		Uraninite.*
Tourmaline.		Gummite.*
Zoisite (var. thulite).		Autunite.
Epidote.		Uranotil.
Enstatite.		Phosphuranylite.
Actinolite.		Columbite.
Cyanite.		Samarskite.*
Pyrophyllite.		Rogersite.
Allanite.		Hatchettolite.
Chabazite.		Fergusonite.
Zircon.*		Monazite.
		Apatite.
		Graphite.

The majority of these minerals are found in the mica mines or pegmatitic dikes of Mitchell, Yancey and Madison counties. In the other mica-producing counties the associated minerals are less in number and rarer.

A number of these by-product minerals are gems; but there are two, feldspar and quartz, that may become of some considerable value, especially the former. This is used in pottery manufacture and by utilizing the available water-powers for grinding it, it should be able to be placed on the market at a fair profit. There are a number of the mines in Yancey county and also Mitchell county that could furnish it in quantity. In the more southern counties the feldspar has usually suffered too much kaolinization to be of value for this purpose.

Uses.

Besides the use of mica for cutting into sheets of varying sizes, which are used for stoves, chimneys for the incandescent lights, etc., there is a large quantity of the smaller pieces of mica that are cut by machines into small circular disks (one inch in diameter), and rectangular pieces ¾x2 inches which are used for insulation purposes in electrical apparatus. While the use for stoves has decreased very rapidly during the past ten years, there has been a corresponding increase in its use for electrical apparatus. Of all the mica that is mined, there is probably not over 10 to 15 per cent. that can be cut into sheet mica, the rest being waste or scrap mica. In some of the mines in the western part of the United States there is hardly a 3 per cent. yield of cut mica. In the North Carolina mines, the mica obtained will average the highest percentage of cut mica. Selected masses or blocks of mica will often average from 30 to 40 per cent. and occasionally as high as 75 per cent. There are a number of reasons for this large percentage of waste mica: The irregularity of the blocks of mica, and of the individual sheets; the "ruled" and "A" mica reduce the size of sheets that can be cut; or prevent entirely any sheets being cut from the block; specked and stained mica; and the destruction of sheet mica by having garnet, tourmaline or quartz crystallized out between the foliæ. Some of the small perfect pieces

of mica from the cutting of the large sheets are re-arranged and cemented together into larger sheets, which are cut into various shapes and are known as micanite. For some purposes the large sheets of micanite answer as well as the perfect sheets and are of course much cheaper. The waste or scrap mica, which is not suitable for any of the above purposes, has a value when ground to a flour as in the manufacture of wall papers, lubricants, etc. Another use for scrap mica that has been devised during the past few years is in the manufacture of a covering for boiler-tubes and steam pipes in general. The scraps of mica are not ground but are broken to approximately the same general dimension—about one-half by a quarter of an inch. These are arranged with their longer direction and face parallel to the length of the coil, which consists of a wire net, pressed into the shape of the pipe or tube and against which is the layer of scrap mica kept tightly in place by means of heavy canvas. This kind of boiler-tube covering can be cheaply made and as mica is a non-conductor of heat, it should give good satisfaction, if not equal to or better than the asbestos coverings. North Carolina offers a very favorable location for a plant to manufacture these as it can produce a large supply of scrap mica and has also an abundant supply of available water-power. It is the commercial value of this scrap mica, which is from $8 to $10 per ton delivered at the railroad, that has made it possible to work some of the mines that would otherwise have been unprofitable; for it must be remembered that this waste mica represents 75 to 95 per cent. of the mica mined.

The value of the plate mica per pound varies with the size of the sheet, which is from 15 cents for the smaller sizes to $3 and more for the larger.

Localities.

During the past year, many of the mica mines throughout the State have been worked quite vigorously, and the result is a larger production of sheet mica than for many years past. The production, however, of scrap mica was less, this being due to the fact that for a number of years the old dumps at the mica mines have been a fruitful source of scrap mica; but as these have been more or less thoroughly culled over, the production is now largely the waste from

present mining. There have been a large number of small producers (from $50 to $500) in the different counties that have worked their mines a few days at a time. There are but few that have been worked continuously throughout the year. A number of new properties, and also old mines, have begun to be worked during the past year, as the mines of the Carolina Mining Company on Beaver creek, near Jefferson, Ashe county; the Mattocks mine near Canton, Haywood county, which is being operated by Mr. J. E. Mattocks; and the Reeves mine near Montvale, Transylvania county. The mica that is being produced in the State does not begin to represent what it should be. By the consolidation of many of the mica mines they could be put on a paying basis and would be profitable to the investor, while by the present method of mining many of them do not more than pay expenses. There are many good deposits of mica in the State that can be worked to advantage and as these are taken up and mining operations for mica are carried on to the same extent as in other kinds of mining, they will be found to be as profitable.

There is no method by which it can be accurately determined from the appearance of a pegmatitic dike at the surface, whether or not at greater depths it will contain large blocks of mica and make profitable mining; but if there is a considerable exposure of the surface dike, and if in this distance there are indications of large blocks of mica, or of mica in paying quantity, it can usually be considered that this represents what will be found deeper. There are a few facts, however, regarding mining and prospecting for mica that can be used to advantage which have been enumerated by Prof. J. A. Holmes as follows:

"Deposits of commercial mica are most likely to be found:

"(1). In regions where the country rock is either mica schist, hornblende schist, or a somewhat schistose gneiss.

"(2). In such of these regions as where the crystalline schists and gneisses contain numerous fairly large and coarsely crystalline pegmatite dikes.

"(3). In a region where these pegmatite dikes have not been greatly crushed or sheared in connection with great earth movements, such as accompany the result in the formation of mountains, it

ing used in the manufacture of a paste that is used for wood finishing; in the manufacture of pottery and tile; of sand-paper; in certain scouring soaps and powders; in the manufacture of a wood filler, and in glass; and in certain instances it is mined for a flux in copper smelting. Where it is colorless and perfectly transparent it is of considerable value for cutting into spheres, cubes and other forms for ornamental purposes. There are also many varieties of quartz that are of value as gems, see page 51.

There are large deposits of quartz in the mountain counties of North Carolina, some of which should be available for some of the first purposes enumerated above. It would not pay to ship the rough quartz, but by utilizing the available water-power, it does seem as though the ground product could be marketed at a profit. As a by-product in mica mining, its cost of production would simply be in the grinding, and with favorable transportation rates, it should be able to compete with quartz produced in other localities. The completion of the railroad in Yancey and Mitchell counties will make this a more feasible proposition for the quartz deposits of those counties.

The only quartz that has been mined in North Carolina during 1901 was in Cherokee county and was used for flux in the copper smelter at Ducktown, Tenn. This amounted to 3,000 tons valued at $7,500. During 1902 this production will undoubtedly be very materially increased.

FELDSPAR.

Inquiries have been received regarding the occurrence of feldspar in North Carolina, that would be suitable to grind and use in the manufacture of pottery. There are two classes of feldspar that can be used for this purpose, the potash and soda feldspars. Of these the potash is the more valuable and more in demand. Orthoclase and microline, the two potash feldspars, have the following theoretical composition:

	PER CENT.
Silica, SiO_2	64.7
Alumina, Al_2O_3	18.4
Potash, K_2O	16.9

There is nearly always a little soda (Na_2O) that replaces a portion of the potash.

The common soda feldspar is albite, which has the following theoretical composition:

	PER CENT.
Silica, SiO_2	68.7
Alumina, Al_2O_3	19.5
Soda, Na_2O	11.8

In this case there is more or less of the soda replaced by potash. Lime, CaO, is often found in small quantity in the soda feldspars and as this begins to predominate there is a transition to the pure lime feldspar, anorthite.

Feldspar is a common mineral in North Carolina as a constituent of all granites and gneisses and of pegmatitic dikes. A great deal of it, however, found near the surface especially in the southern counties has been either partially or wholly kaolinized, so that it is not of value as a feldspar for pottery manufacture; but in many cases has formed extensive beds of kaolin. In the northern counties, however, fresh unaltered feldspar occurs in quantity. These are found for the most part as constituents of pegmatitic dikes that are being worked for mica, and its production would be in many cases a by-product of mica mining. In the table below are given the localities and percentages of potash, soda and lime of a number of feldspars.

NORTH CAROLINA FELDSPARS.

	PER CENT.				
	Potash. (K_2O)	Soda. (Na_2O)	Alumina. (Al_2O_3)	Lime. (CaO)	Silica. (SiO_2)
1	11.66	5.95	18.34	.08	64.25
2	9.50	3.62	21.20	Trace.	63.52
3	8.73	6.65	20.20	Trace.	63.55
4	8.39	7.64	19.66	Trace.	62.95
5	7.55	7.85	19.24	Trace.	64.75
6	7.28	7.00	19.04	.12	65.15
7	3.94	7.91	22.26	1.41	64.55
8	2.91	10.04	19.90	None.	64.85
9	.04	8.35	21.60	.64	65.18

1. Young mine, Dobag, Yancey county.
2. Irby mine, near Spruce Pine, Mitchell county.
3. Ray mine, near Burnsville, Yancey county.
4. Averys Meadow mine, Plumtree, Mitchell county.
5. Tolly Bend mine, near Micaville, Yancey county.
6. Flat Rock mine, Flat Rock, Mitchell county.
7. Charlie Robertson mine, near Micaville, Yancey county.
8. Wiseman mine, near Spruce Pine, Mitchell county.
9. Cloudland mine, near Bakersville, Mitchell county.

With the water-powers that are available in the vicinity of where these feldspar deposits occur, which could be utilized for grinding them, and with the construction of the railroad across these counties, connecting with the Ohio River railroads, the ground feldspar should be able to be landed at the potteries in competition with that from other localities.

When it is considered that there are to be found in North Carolina as fine beds of clays as can be obtained; that the other constituents necessary for pottery manufacture are also at hand; and that manufacturing can be carried on as cheaply if not more so than in the Northern States, the question arises why should not pottery industries themselves be established in North Carolina, instead of shipping out the raw materials necessary to maintain these elsewhere.

GEM MINERALS.

There are many of the gem minerals found in North Carolina, and deposits of some have been found in sufficient quantity to become regular producers. There has been but little systematic search for these minerals, but accidental discoveries have been made in various places that have in some cases led to the opening of good deposits of gem material, and there are now a number of companies who are mining in the State exclusively for gems. The principal gem localities are in Macon, Yancey, Mitchell, McDowell, Burke, Alexander and Iredell counties.

The minerals that are classified as gem minerals can be brought under three groups; one consisting of those that are capable of being cut into gems for jewelry, as diamond, ruby, etc.; another consisting

of those that are cut into spheres, cubes and other forms, or are carved, and which are used for ornamental purposes, as quartz, serpentine and jade; and third, those that make handsome mineral specimens, as rhodochrosite, pyrite, etc. In the following list are given the minerals that come under some one of the above groups that are known to occur in the United States, and those that have already been found in North Carolina are marked with an asterisk.

LIST OF GEMS AND GEM MINERALS OCCURRING IN THE UNITED STATES.*

Diamond.*
Corundum, oriental ruby.*
oriental sapphire.*
oriental emerald.*
asteriated sapphire.*
oriental amethyst.*
oriental topaz.*
Topaz.
Beryl, acquamarine.*
emerald.*
golden.*
blue.*
emerald matrix.*
Garnet, almandine (precious).*
essonite (cinnamon).*
pyrope (Bohemian).*
rhodolite.*
spessartite.*
schorlomite (titaniferous).
topazolite.
uvarovite.
Tourmaline, achroite.
Brazilian emerald.
indicolite.
rubellite.
Quartz, rock crystal, "pebble."*
amethyst.*
citrine.*
smoky quartz.*
cairngorm stone (Scotch topaz).*
Spanish topas.*
morion.*
plasma, prase.*
rose quartz.*
asteriated quartz, "star quartz."
aventurine.*
quartz, cat's eye.
gold-quartz.*
tourmalinated quartz.*
hornblende in quartz.*
gothite in quartz, onegite.
rutilated quartz, sagenite.*
fleeches d'amour.
Thetis hairstone.*
agate.*
carnelian.*
chalcedony.*
chrysoprase.*
hydrolite.
moss-agate, mocha stone.*
onyx.
rainbow agate.
royal agate.
sard.
jasper.*
bloodstone (heliotrope).
jasper, agate.*
Lydian stone (basante, touchstone).
novaculite.*
silicified wood.
agatized wood.
jasperized wood.
Opal, opal agate.
fire opal.
lechosos (milky opal).

*This list has been made up from one used by Mr. George F. Kunz, of the U. S. Geological Survey.

moss opal.
noble (precious).
sun opal.
opaline, opal matrix.
hyalite.*
hydrophane.
wood opal.
opalized wood.
Feldspar, labradorite.*
microcline (amazon-stone).*
oligoclase (sunstone).*
orthoclase (moonstone).*
obsidian (volcanic glass).
marekanite (mountain mahogany).
moldavite.
Bronzite.*
Pyroxene (diopside).*
Hypersthene.*
Spodumene, hiddenite.*
Nephrite.
Pectolite.
Rhodinite.
Crocidolite.
Iolite (cordierite).*
Sodalite.
Lazurite (lapis lazuli).
Olivine (chrysolite, peridot).*
Phenacite.
Scapolite (wilsonite).
Willemite (troostite).
Zircon.*
Cyanite (blue and green).*
Andalusite (macle, chiastolite).
Zoisite (thulite).*
Epidote.*
Chlorastrolite.
Prehnite (zonochlorite).
Thomsonite (mesolite).
Chondrodite.
Dumortierite in quartz.
Serpentine.*
Agalmatolite (figure stone).
Catlinite (pipestone).
Chrysocolla.
Titanite (sphene).*
Pyrite.*
Hematite.*
Rutile.*
nigrine.
Diaspore.
Prosonite.
Malachite.
Azurite.
Rhodocrosite.
Turquoise.
turquoise matrix,
odontolite (bone turquoise).
Variscite.
utahlite.
Amber.
Fire marble (lumachelle).
Fossil coral.

With more systematic search for these minerals, others will be found in North Carolina and some of those already known will be found in greater abundance.

Diamond.

In North Carolina diamonds have been repeatedly found; and there are now ten authentic ones whose occurrences are fully established. Besides these, three others have been reported. They have been distributed over a wide area in the counties of McDowell, Burke, Rutherford, Lincoln, Mecklenburg and Franklin. With the exception

of Franklin, all of these counties are in the eastern drainage basin of the Blue Ridge. Two have been found on Brindletown creek, Burke county; one at the Twitty mine in Rutherford county; one near Cottage Home, Lincoln county; two on Todd Branch, Mecklenburg county; three from Muddy creek, McDowell county; and one from the Portis mine, Franklin county. Besides these, one is reported from Richmond county, and another from Rutherford county. The largest diamond, weighing 4 1-3 carats, was found in 1886 on the farm of Albert Bright in Dysartville.

Corundum Gems, Ruby and Sapphire.

There is no State or country that excels North Carolina in its variety of corundum gems. They are found red, ruby-red, sapphire-blue, dark blue, various shades of green, violet and purplish, rose, pink, brown, yellow, gray and colorless. The corundum gems are determined by the color and there are, at the present time, nine varieties that are commonly recognized by the lapidaries. In the arts these are usually prefixed by the word "oriental" to distinguish them from other gems of the same name, but whose mineral composition and character are entirely different. These varieties are as follows:

LIST OF CORUNDUM GEMS.

Oriental or true ruby	Red of various shades.
Oriental Sapphire	Blue of various shades.
Pink Sapphire	Rose or Pink.
White Sapphire. Diamond spar.	Colorless.
Opaline. Girasol. Hyaline.	Pale blue or bluish white.
Oriental Amethyst	Purple.
Oriental Emerald	Green.
Oriental Topaz	Yellow.
Star Sapphire. Chattayant. Asteria.	Opalescent.

The locality that has furnished the greatest variety of these gems is the Corundum Hill mine, at Cullasaja, Macon county. Sapphires

have also been found at the Grimshawe mine, Montvale, Transylvania county, and at Sapphire, Jackson county.

The North Carolina locality which has attracted considerable attention for the occurrence of corundum gems is a tract of land in Macon county, between the Caler fork of the Cowee creek and Mason Branch, two tributaries of the Little Tennessee river. Ruby corundum of exquisite color and transparency has been found in the gravel deposits of the Caler fork of Cowee creek. Although but a very small percentage of the corundum found in the gravel was transparent, nearly all was of the ruby color. Beautiful rubies of a rich pigeon blood red color have been found here, that could not be told from the Burmah stones. The best stone that has thus far been found is valued at $1,500. Many smaller gems have been obtained that were perfectly transparent and of good color. Sapphires to the value of about $45 were obtained in 1901.

Rhodolite.

Associated with these rubies is the gem rhodolite, one of the garnet group. It has a variety of shades of color, which for the most part are similar to the delicate rose-like tint of the rhododendron. Then again, its remarkable brilliancy vies with that of the diamond. Most of the varieties of garnet are only beautiful by transmitted light and otherwise exhibit dark shades of color, but rhodolite gives most striking effects of beautiful and varied coloring by reflected light. When first discovered the rhodolite was mistaken by many jewelers for a variety of ruby, and not until they had tested it would they believe otherwise. The rhodolite has only been found in North Carolina, and in a very limited area, which includes the gravels of the streams that rise on Mason mountain, Macon county. The largest rhodolite found in 1901 weighed 43½ carats. The value of these gems found in 1901 was $20,350.

Garnet Gems.

Beside the rhodolite referred to above, the almandite and pyrope varieties of garnet have been found extensively in many sections of the State. Good gems of these varieties have been found in Macon, Alexander, Yancey, Mitchell, McDowell, Burke, Caldwell, Ca-

tawba and Lincoln counties, but the best colored and most transparent ones have been obtained from the first two counties. At many of the mica mines, transparent garnet crystals are found, flattened out between the foliæ of the mica. Otherwise than as gem minerals garnet is widely distributed in the State, and is a constant constituent of many of the micaceous and other igneous rocks, and as stated on page 36, occurs at times in sufficient quantity to be of value for abrasive purposes. The value of these garnets obtained in 1901 was $625.

Beryl.

This is a mineral that varies in color from emerald green, pale green and sea green to yellow, light blue, and white. The emerald green color is due to the presence of a little chromium and that variety is highly prized as a gem when clear and free from flaws. The beryl emerald is the one that is commonly sold at the present time, the oriental or true emerald (the green variety of sapphire) being one of the rarest of the gem stones. North Carolina has furnished some very handsome beryls of emerald green color, some of which have been cut into fine stones. The most noted locality is near Hiddenite, Alexander county, North Carolina. The first emeralds that were obtained in this locality were found in the soil and it was not until 1881 when the Emerald and Hiddenite Mining Company was organized that any direct mining was undertaken. As the deposits were followed downward through the soil, the unaltered rock was encountered and, as the work was extended into this, their exact occurrence was seen. They occur in pockets of quartz associated with rutile, hiddenite, quartz, muscovite, dolomite, pyrite, garnets, etc., all of which are well crystallized. The rutile found here is the finest that has been observed in any locality in the world. It is a mineral of a nearly black color by reflected light, but a deep red in thin splinters by transmitted light and is often used for cutting into stones for seal rings as a substitute for the black diamond which it somewhat resembles when cut. The quartz associated with the emeralds is exceptionally well crystallized and has furnished some of the most modified crystals ever found.

The largest emerald crystal found here was a very perfect specimen

of a fine but somewhat light green color, which was doubly terminated and weighed 8¾ ounces. One of the largest stones cut weighed 4⅞-carats and was of a somewhat light green color.

On Crabtree mountain, between Brush and Crabtree creeks, Mitchell county, emerald beryl occurs in a pegmatitic vein. No very large crystals have as yet been found at this locality, but some have been taken out that have cut small gems of a deep emerald color. Matrix specimens of emerald with feldspar, tourmaline or quartz are being cut en cabachon and they make handsome and attractive stones.

The aquamarine variety of beryl is found very commonly in many of the pegmatitic dikes that have been worked for mica. The most important of these are in the vicinity of Spruce Pine, Mitchell county, at the Ray mine, Yancey county, and the Littlefield mine, Macon county, where transparent aquamarine beryls have been found very abundantly that have cut many beautiful gems. Beside the aquamarine, blue beryl has been found in fine crystals in the mines near Spruce Pine, Mitchell county, so also has the yellow or golden beryl. The Wiseman property near Spruce Pine, Mitchell county, is a promising field for aquamarines and has furnished pieces up to 20 carats in weight. The value of the beryls of all varieties mined during 1901 was $2,250. Of the beryls found during 1901, the largest aquamarine weighed, when cut, 11 carats, the largest blue beryl, 26 carats, and the largest yellow or golden beryl, 6 carats.

Hiddenite.

This gem is a variety of the mineral spodumene, a lithium alumium silicate, and is of a yellowish-green color, due probably to the presence of minute quantities of chromium. Hiddenite has only been found at the emerald locality at Hiddenite, Alexander county. While some of the crystals have a uniform green color, they are generally yellow at one end and graduate through yellowish-green to a green at the other. The hardness of the hiddenite is below that of quartz, being but 6.5 to 7, but on account of its rarity, color, and very brilliant lustre, it ranks at the present time as one of the most expensive gems. The finest crystal that was obtained from this locality measured 2 3-5 inches by ½ inch by ¾ inch, with one end of a very

fine green color and would probably afford a gem, if cut, which would weigh about 5½ carats.

Quartz.

This mineral is very varied in its occurrence and is found in many colors and forms, furnishing many varieties of gems. The more important of these gem varieties are given below:

Rock crystal has been found in many beautiful transparent crystals and masses from White Plains, Surry county; Hiddenite, Alexander county, and Chestnut Hill, Ashe county.

Smoky quartz or Cairngorn stone is found in quantity in Burke and Alexander counties.

Amethysts of a beautiful deep purple color have been found at a number of localities in the State, principally in Macon, Lincoln and Catawba counties.

Sagenite or Venus Hairstone is crystalline quartz that is penetrated with a net-work of acicular crystals of rutile. Some of the most beautiful specimens of this rutilated quartz have been found in Alexander and Iredell counties. It has also been found in Catawba, Burke and Randolph counties.

Citrine or Spanish topaz is a yellow variety of quartz that has been found in Burke and adjoining counties, but seldom of a rich deep color.

Other quartz gems that have been found in North Carolina are chrysoprase, from Macon county; rose quartz, and morien, from Alexander county; aventurine from Iredell county; chalcedony; agate; jasper; and carnelian. The value of the quartz gems found during 1901 was about $355.

Other Gem Minerals.

The feldspar that is a constituent of the pegmatitic dikes of Mitchell and Yancey counties, is occasionally met with of good quality for cutting into moonstones and sunstones.

Beautiful crystals of rutile are obtained from Alexander county that have been cut into gems that resemble black diamonds.

Fine blue crystals of cyanite are obtained in Mitchell and Gaston counties. Near Spruce Pine, Mitchell county, some of the finest grass-green cyanite that is known has been discovered.

Staurolite, zircon, spinel, peridot, lazulite, and serpentine are among the other gem minerals that have been obtained in the State.

The total value of gem minerals produced in 1901 was $24,245 as compared with $12,020 in 1900. This production was divided as follows:

PRODUCTION OF GEM MINERALS IN 1901.

Name.	Value.
Rhodolite	$ 20,350
Other garnets	625
Beryls	2,250
Sapphires	45
Quartz gems	355
Other gems	20
Mineral specimens	600
Total value	$ 24,245

MONAZITE.*

Monazite, which is essentially an anhydrous phosphate of the rare earth metals cerium, lanthanum and didymium, usually contains a varying but small percentage of thoria and silicic acid, which are very probably united in the form of a thorium silicate. It is the presence of this thoria that gives the monazite its commercial value, and this varies from a fraction of a per cent. to 32 per cent., but the majority of the monazite samples contain from 3 to 9 per cent. of this oxide. The mineral is a light yellow to honey yellow, reddish, brownish, or greenish-yellow in color, with a resinous to vitreous luster, and is brittle, breaking with a conchoidal to uneven fracture. Its hardness is from 5 to 5.5 (being readily scratched by feldspar) and has a specific gravity of 4.64 to 5.3.

Occurrence.

Monazite is found very widely distributed as an accessory constituent in varying proportion in many granites and their derived gneisses; but the commercial deposits have thus far not been found in the original rocks, as they contain but a fraction of a per cent. of this mineral, but are found in the placers of the present streams and

*See also Bulletin No. 9.

rivers and in the old sands and gravel deposits of former streams. By the decomposition and disintegration of these crystalline rocks, which in the Southern States has proceeded to considerable depths, and by erosion, the constituents of these rocks are deposited in the stream beds, the heavier minerals being deposited first and nearer where they originated, and thus the richer deposits of monazite in these placer gravels or sands are found nearer the source of the original rocks. Monazite has been found in the granitic mica gneisses and hornblende gneisses of the South Mountain Region of North Carolina, covering an area of some 2,000 square miles in McDowell, Burke, Rutherford, Cleveland, Polk, Catawba, Lincoln and Gaston counties, and from the alteration and erosion of these rocks have been formed the extensive deposits of these counties which have been the chief sources of all the monazite mined in the United States. These workable deposits are found along the streams that have their sources in the South mountains, and they are Silver, South Muddy, and North Muddy creeks and Henry and Jacobs forks of the Catawba river, in McDowell and Burke counties; the Second Broad river and tributaries in McDowell and Rutherford counties; and the First Broad river and tributaries in Rutherford and Cleveland counties. In recovering the monazite, the sands and gravels are sluiced similarly as placer gold is washed, and, after drying the resulting concentrates, the magnetite, ilmenite, etc., are separated by means of the electro-magnet. As the value of the sand depends upon the percentage of thoria, and as this is dependent in turn upon the percentage of monazite in the sand, it is to the producer's advantage to make his sand as nearly pure monazite as possible. One company is erecting a mill near Shelby, Cleveland county, North Carolina, to treat the saprolitic rock containing the monazite, claiming that they can get a purer product than from the placer deposits. From the experiments that they have made, they believe that they can work these decomposed gneisses at a profit.

There are given below the percentages of Thoria (ThO_2) that have been found in some of the commercial monazite sands of North Carolina:

PERCENAGE OF THORIA (ThO_2) IN NORTH CAROLINA MONAZITE SAND.

	PER CENT.									
	1	2	3	4	5	6	7	8	9	10
ThO_2	2.18	2.25	6.54	1.27	6.30	2.48	5.87	6.26	3.98	1.93

1. White Bank Gold mine, Burke county.
2. Hall Creek, Burke county.
3. Linebacher Place, Silver Creek, Burke county.
4. Long Branch, McDowell county.
5. Alexander Branch, McDowell county.
6. MacLawrath Branch, McDowell county.
7. Proctor Farm, near Bellwood, Cleveland county.
8. Wade McCurd Farm, Carpenters Knob, Cleveland county.
9. Davis Mine, near Mooresboro, Cleveland county.
10. Henrietta, Rutherford county.

The monazite concentrates obtained from working the saprolitic gneisses is said to contain 7.01 per cent. of thoria. Sand is reported to have been obtained in Burke county that contains 7.28 per cent. of thoria.

As is seen from the above, there is a wide variation in the percentage of thoria in the commercial monazite sands. This percentage can be, in many cases, very materially raised, by more careful washing of the gravels, and using the electro-magnet in the separation of the iron minerals. In some instances the monazite deposits contain more or less gold, so that they can be worked for this metal, leaving the monazite as a valuable by-product.

The thoria contents of the monazite is used in the manufacture of the cylindrical hood or mantle of the Welsbach and other incandescent gas lights. The cerium oxalate, obtained in the separation of the rare earth oxides, is used in pharmacy. There are also very small quantities of lanthanum and didymium oxides used with the thoria in the manufacture of the cylindrical mantles.

There was a considerable increase in the value of the monazite pro-

duced in 1901 over that of 1900, although the amount was less, and was 748,736 pounds valued at $59,262 as compared with 908,000 pounds valued at $48,805 in 1900. While this increase in the value per pound of the monazite is partially due to an increase in the price of the sand, it is also partly due to the fact that the production reported is cleaner sand and, therefore, higher in thoria. The actual amount of thoria produced in 1901 is probably fully as much, if not more, than that produced in 1900. The price of monazite received by the original miner varies from 3½ to 5 cents per pound, but the further cleaning to which the material is subjected, increased its value to 8 cents per pound. The larger amount of the monazite was obtained from Burke and Cleveland counties with smaller amounts from McDowell and Rutherford. There is a considerable demand for North Carolina monazite both in this country and abroad, and during the past few months (December, 1901, to February, 1902) a number of representatives of German manufacturers have been in the monazite districts of North Carolina investigating the field with a view to purchasing deposits. One tract of 353 acres is reported to have been bought near Ellenboro, Cleveland county. It is very probable that the production of 1902 will exceed both in value and amount by a considerable figure that of 1901.

In the following table is shown the production of monazite for the past ten years:

PRODUCTION OF MONAZITE IN NORTH CAROLINA FROM 1893 TO 1901.

	Pounds.	Value.
1893	130,000	$ 7,600
1894	546,855	36,193
1895	1,573,000	137,150
1896	30,000	1,500
1897	44,000	1,980
1898	250,776	13,542
1899	350,000	20,000
1900	908,000	48,805
1901	748,736	59,262

Prior to 1893 there were a few tons per year shipped from different points, but the exact amount is not known. In 1887 the first mona-

zite was shipped from North Carolina, amounting to 24,000 pounds, and was obtained from Brindletown creek, Burke county. By 1893 the monazite industry was well established and continued to increase very rapidly until 1895, when 1,573,000 pounds were produced valued at $137,150. It was at this time that the Brazilian deposits began to be worked and it at once affected the production in the United States, which dropped to 30,000 pounds. In 1898 the industry began to revive and has gained steadily each year, until once more it seems to be firmly established.

BARYTES.

The mineral barytes does not usually occur in well defined veins except when an accessory mineral in certain metallic veins; but is more often found in a series of pockets, lenses, or seams of varying dimensions. These are more or less in line often following the dip of the rock with which they are associated and this rock is in many cases a limestone. Barite is a heavy white mineral with a perfect prismatic cleavage and is known commercially as barytes. In chemical composition it is a barium sulphate ($BaSO_4$).

The larger proportion of the barytes mined in North Carolina is sold in the crude state direct to the manufacturers, and but a small part is subjected to any treatment before being sold, beyond the washing off of the attached dirt and soil. In preparing the barytes for use, it is cleaned, crushed and some is bolted and some floated. This flour barytes is used in the manufacture of paper, rubber, paints, and in the preparation of a material that is used to coat canvas sacks in which hams are sold. Only the first grades are used in the manufacture of paints, by mixing with white lead, and it is known as "floated barytes." Where it is too much stained with iron oxide to be available for the above purpose, it is beginning to be used in the manufacture of various barium salts. Experiments are also being made as to its value in the glass industry; but no definite results have thus far been obtained.

The barytes deposits of North Carolina that have been worked the most extensively during 1901 are in Madison county in the vicinity of Marshall, Stackhouse, and Sandy Bottom and Hot Springs. It occurs in small seams and elongated pockets, varying from 3 to 10 feet

in width and is very free from impurities. About 3½ miles southeast of Hillsboro, Orange county, near the Chapel Hill road, this mineral of good quality has been found and is very probably in quantity. This property is now being developed by Mr. T. G. Fry of Goldsboro, N. C. The production of barytes in North Carolina in 1901 was all confined to Madison and Gaston counties and amounted to 7,390 tons valued at $22,615. There have been many inquiries received during the past year regarding localities where this mineral occurs. This has led to the development of the deposit near Hillsboro, and it is very probable that there will be a considerable increase of the production of this mineral in 1902 over that of 1901.

At the Stackhouse mine, what appeared to be two veins at the surface have with depth come together, making a total width of barytes of over 9 feet. Outcroppings of barytes have been observed on the surface for a distance of 2,200 feet. It is expected that the output of this mine will be largely increased during 1902.

The barytes mined by the Carolina Mineral Company is cleaned and ground at their mill at Marshall, and is the only barytes mined in North Carolina that is thus treated. There are one or two individual operators of barytes in this district, but most of the output is controlled by one company.

Lawson Barytes Mine, near Bessemer City, N. C.—The barytes deposit is located about five miles nearly due south from Bessemer City, Gaston county, a station on the Southern Railway, and is about one mile a little east of south of the north end of the peak of Crowder's mountain. The elevation at the mine is somewhat higher than the railroad at Bessemer City and a perfect graded road could readily be built from the mine to the railroad at a point which would be distant about four miles from the mine.

Crowder's mountain, near which the mine is located, is one of a line of isolated peaks and ridges which stretches from the South Carolina line northeastward, the most noted ones of those peaks being Kings, Crowder's and Anderson mountains. These mountains rise from 500 to 1,000 feet above the average elevation. The country rocks of this district are for the most part crystalline schists and gne-

isses, the former being micaceous, chloritic, argillaceous, and sometimes graphitic; the latter are micaceous. The strike of the schistosity of these rocks is in a general direction northeast, and the dip generally westward at very steep angles. Occasionally lenticular bodies of sileceous, magnesian limestone have been observed, but none were found to the eastward of Crowder's mountain in the vicinity of the barytes deposits, although they have been found to some extent to the westward of this mountain and between it and King's Mountain. Quartzite has been observed as forming the higher ledges of the mountains.

Barytes has been found at a number of points in the vicinity of King's and Crowder's mountain, and occurs in what at first appear to be regular well defined fissure veins between walls of a micaceous, argillaceous schist. The barytes outcrops at intervals and has been encountered by open cuts and pits at numerous points throughout a distance of 2,400 feet. The main deposit, or so-called vein, varies in width, as now exposed in the underground workings, from 2½ to 6 feet and at one point it was observed 12 feet in width. As the deposit was followed down from the surface, it was found to widen from a few inches to a foot to the width mentioned above. To the west of this main deposit there is another, approximately parallel, which, however, is not as wide. There are also small seams of barytes that were observed directly east and west of this main vein and separated from it by narrow bands of schist. About 400 feet to the east another vein that is approximately parallel to the first has been encountered. The strike of the barytes veins is in general approximately north 10° to 15° east and dipping at high angles, usually toward the west. In some places they are nearly perpendicular. As will be noticed, the strike and dip of the barytes correspond closely to the strike and dip of the schistosity of the schist. Where the barytes was encountered near the surface and followed downward, it increased in width; but there was considerable variation in the width as followed along the strike; in two or three instances, where it has been followed along the strike, the barytes narrowed down to a thin seam. At lower levels, however, following the same direction and at

a corresponding point on the strike, the barytes was found to be much wider. This, with the other phenomena noted, would indicate that the barytes is occurring in lenticular masses whose strike and dip are conforming to those of the schist and are pitching toward the south. One of these lenses is at least 400 feet in length, as it has been opened up for this distance by means of drifts; but it is undoubtedly considerably longer.

The barytes very probably represents the filling of fissures and crevices in the schist which may have been caused by the faulting and the tearing apart of the schist. This method of formation of these deposits of barytes would readily account for the finding of the large main veins of barytes and the smaller seams approximately parallel to them. These lenticular veins may be found to be many hundreds of feet in depth and then be connected by a thin seam of barytes with another. Judging from the length of the barytes lenses already observed, it may be expected that they will be followed for a number of hundred feet before they begin to pinch out.

Where the barytes is more or less cracked and seamed, it is badly stained with iron oxide, but with deeper mining this began to grow less. There are some sulphides found associated with the barytes such as galena, and sphalerite; but as far as observed, these have been along certain lines and not scattered through the barytes. In breaking up the masses of barytes which contain these streaks of sulphides, it readily breaks, following these seams, and the sulphides can as a rule be readily eliminated by hand-cobbing with but very little waste of the barytes. By giving a little care to the hand-cobbing of the barytes, by far the larger proportion of the iron-stained barytes, which is due to seams and cracks, can be eliminated. Most of the barytes is free from grit, especially in the wider portions of the deposit, but occasionally along the contact or in the narrower portions, some barytes was encountered that contains grit; but this can readily be kept separated from the first quality of barytes.

It is usually granular in structure, but occasionally masses of some size are obtained that are made up of cleavable blocks. The quality of the barytes, as a whole, is good and by giving some care to its selection, barytes of the first quality can be obtained.

OCHER.

In Henderson county, about 4½ miles southwest of Saluda and one fourth of a mile from the Polk county line, on land belonging to M. M. Staton, there is an ocherous clay that occurs in quantity. This has been used as a paint pigment and is said to give satisfaction. Saluda, on the Southern Railroad, is the nearest point on the railroad and is connected by a good road.

In the vicinity of Tomotla, Cherokee county, ocher has been found to some extent, but sufficiently large deposits have not as yet been discovered that would justify the erection of a plant for preparing it for market. In the vicinity of Wilson's Mills, Johnston county, on the land of Mr. W. G. Wilson, ocher deposits of some promise have been discovered. Mr. C. H. Womble of Glendon, Moore county, has reported the occurrence of yellow ocher near that place, where it is believed to occur in quantity.

Near Rockingham, Richmond county, on land belonging to Mr. Steele, red and yellow ocher of good quality has been found. They make a good pigment, and the property is worthy of further investigation.

TALC AND PYROPHYLLITE.

The demand for talc and the similar mineral pyrophyllite is constantly increasing and this is causing a considerable interest to be centered in the North Carolina deposits of Swain, Cherokee, Moore, and Chatham counties.

The properties of these minerals, that make them suitable for the purposes for which they are to be used, are their extreme softness (being among the softest minerals known); their purity or freedom from grit; their stability; and their smooth, slippery touch. When the talc is of sufficient compactness, it is sawed into pieces of various shapes and sizes; gas tips; and into different styles of pencils. The larger proportion of the talc and pyrophyllite which are mined is ground to a flour, similarly as mica, and used in the manufacture of talcum powder; in wall paper; as the basis of many lubricants; in paper; and in the manufacture of some of the cheaper varieties of soap.

The impure varieties of the mineral talc, which are known as soap-

stone, contain more or less grit and are not as a rule suitable for the purposes enumerated above. It is, however, quarried to a large extent for manufacturing into various soapstone articles, as griddles; boot and shoe dryers; table tops for laboratories, ovens, etc. It is also used to some extent for chimneys and for lining fire-places. For this latter purpose it has been quarried in small quantity at a number of places in the mountain sections of the State.

The talc deposits of Swain and Cherokee counties are found in connection with the marble formation of this section of the State. What was formerly supposed to be a regular vein of the talc was probably a series of pockets of this mineral of varying thickness, lying for the most part directly between the marble and the quartzite, although at times they are entirely enclosed by the marble. None, however, have been observed that were enclosed by the quartzite. These pockets, which resemble in shape flattened lenses, always follow the dip of the strata in which they occur, and are therefore encountered in all positions from horizontal to vertical.

The pyrophyllite deposits are located in the extreme north central portions of Moore and the south central part of Chatham counties, and can be traced across the country for a distance of eight miles. The principal mining that has been done is near the boundary between the two counties in the vicinity of Glendon, Moore county. They are associated with the slates of this region but are not in direct contact with them, being usually separated by bands of siliceous and iron breccia, which are probably 100 to 150 feet thick. These bands of breccia contain more or less pyrophyllite, and they merge into strata of pyrophyllite schist. Between these and the massive beds of pure pyrophyllite there are very often small seams of quartz and larger lenticular quartz masses several feet thick.

The beds of this mineral are not entirely of commercial quality, but there are bands of the pyrophyllite that are highly siliceous alongside of those that are entirely free from grit. Although the general appearance of the waste and good material is very similar, they can readily be distinguished by the touch, and can readily be kept separate by hand cobbing.

The more important talc mines in the State are the Hewitt and Nantahala in Swain county and the Hillyer in Cherokee county. Of the pyrophyllite mines, the Snow, Womble, and Rogers creek are the largest and are all in Chatham county.

Production.

As these two minerals are used for the same purposes, their production is given together and in 1901 it amounted to 5,819 tons valued at $77,824. This is an increase of 2,319 tons and of $35,824 in value over the production of 1900, which was 3,500 tons valued at $42,000. This large increase is due to the re-opening of the Hillyer mine in Swain county, the Snow mine in Moore county and a general increase in the production of the other mines. Besides that above, there was a small amount of soapstone that was quarried for cutting into slabs for chimneys, etc.

The different forms in which this talc was marketed are shown in the following table:

TALC PRODUCTS OF NORTH CAROLINA IN 1901.

	1901.	
	Tons.	Value.
Ground talc, for powders, etc.	2,864	$ 29,505
Talc cut into pencils, gas tips, etc.	375	26,000
Talc sold crude	2,580	22,319
Soapstone cut into slabs for chimneys, etc.		150
Total	5,819	$ 77,974

The demand for North Carolina talc is really greater than the supply; and there are other deposits in the talc belt that are worthy of investigation. Notwithstanding the large increase in the production of talc in 1901 over that of 1900, the production of 1902 will probably be still greater.

GRAPHITE.

Graphite commonly occurs in embedded foliated masses and also in granular, compact, and micaceous masses, sometimes as a solid struc-

ture and at other times earthy. It is sparingly found in 6-sided and tubular crystals, and this with the foliated variety has a perfect basic cleavage, the thin laminæ that separate being flexible but not elastic. In color it is black to a dark steel gray and has a metallic to sometimes dull and earthy luster and a greasy feel. It varies in hardness from 1 to 2. The chemical composition of graphite is theoretically pure carbon, but it is often impure from the presence of iron sesquioxide, clay, quartz, etc. The properties of graphite that make it specially valuable for the purposes for which it is used in the mechanic arts, are softness, flexibility, low coefficient of friction, conductivity, adhesiveness and exceedingly slow oxidation at high temperatures.

The different grades of graphite are used for different purposes; the best grades, which are practically pure graphite, are used in the manufacture of lead pencils, lubricants and for electrical purposes. The other grades are used in the manufacture of crucibles, stove polish, foundry facings and in the manufacture of paint for metallic surfaces. The largest use of graphite is undoubtedly in the manufacture of crucibles.

The amount of graphite mined in the United States is comparatively small when compared with the amount that is imported. The production of graphite in this country has increased very materially in the past two or three years, but this is also true of the importation, and thus there is a wide opening for graphite mining in this country; and any newly discovered deposit of this mineral that is near the railroad is worthy of investigation. There have been many inquiries regarding the occurrence of graphite in North Carolina by those interested in obtaining deposits of this mineral, and during 1901 considerable attention was given to the investigation of these deposits.

Occurrence.

As a mineral, graphite is widely distributed in nature, occurring in gneisses, mica schists and crystalline limestones, but as an ore deposit, it is found in but few places and occurs in beds and embedded masses and in laminæ or scales in these rocks. Schists have been observed impregnated with graphite to such an extent that they become graphitic schists and have been found extending over a number

of miles of territory. Graphite deposits of some considerable promise have been found in Yancey, Mitchell, McDowell, Burke, Catawba, Wilkes and Wake counties. At Graphiteville, McDowell county, an extensive plant is being erected by the Connally Graphite Works to mine and manufacture the graphite that occurs in this section. The deposit consists of an extensive series of bodies of graphitic schists in a country rock of mica schist and gneiss, the schists varying widely in their percentage of graphite. These graphitic schists can be traced for a distance of about 3 to 4 miles in a N. E.-S. W. direction from Brush mountain on the west to Fork mountain on the east. The deposits first became prominent near Mill creek trestle of the Southern Railroad. The schists cross up and down 5 ridges, each of which rise to a height of 500 feet or more above the general level of this section of the country. The aggregate amount of graphite in this deposit is enormous, but it presents certain problems in its purification and the method to be used is one discovered by Dr. J. W. Ihne, who is general manager of the company.

Similar deposits occur in Burke and Wake counties. In the latter county, however, the percentage of graphite is apparently greater, as also the extent of these deposits. These Wake county deposits are found in a belt extending in a N. E.-S. W. direction with about the middle of the belt 2½ miles west of Raleigh. The two more promising properties on this graphite belt belong to the Tucker estate (care of Chas. H. Belvin), Raleigh, North Carolina, and the other to Mr. E. McK. Goodwin, Morganton, North Carolina. The graphite deposit on the former of these properties is first encountered near Method depot on the Southern Railway, and can be traced for 8 or 9 miles toward the northeast, and for two or three miles to the southwest. The best graphite has been found in that portion of the deposit to the north of Method and it has been worked to a limited extent for a number of years. For crucible and foundry purposes this graphite is well adapted. The other property lies just north of the Holly Springs road, about 4 miles from Raleigh and about 2½ miles from Caraleigh Mills, a siding of the Southern Railway.

In Catawba county, graphite deposits 9 miles east and southeast of Newton have been developed to some extent. The principal work

was done nearly 30 years ago. Several shafts were sunk and a considerable quantity of graphite was taken out, cleaned and shipped. Deposits in the same vicinity are now being worked by A. P. Lynch and W. R. Selfand of Newton. They have sunk a shaft 20 feet deep on the deposit and report that a better quality of graphite was encountered in the bottom of the shaft than near the surface.

All the graphite occurring in these deposits is of the amorphous variety and will only make what are called the second and third grade ores, but these grades constitute by far the larger proportion of the graphite used.

One of the most interesting graphite deposits in the State is one in Alexander county, about 5 miles from Taylorsville. The properties upon which this graphite has been found are first encountered about 5 miles a little south of west from Taylorsville on the eastern and northeastern slopes of Barretts mountain, and graphite has been observed at intervals for a distance of over two miles in a direction a few degrees west of south.

The country rocks are schists and gneisses, cutting through which are pegmatitic dikes varying from a few inches to five (5) feet or more in thickness. The graphite occurs in these pegmatitic dikes and is in the form of small particles and nodules from a fraction of an inch to six or more inches in diameter. Wherever these pegmatitic dikes have been observed, they have been badly decomposed and but very little fresh feldspar has been observed in them. The graphite is of good quality, some being of a nearly crystalline character. In the deeper workings there was but little of the graphite stained with iron oxide. On breaking open the nodules of this mineral, they were found to be nearly pure, and on testing them, no grit was observed. The quality of the graphite seems to be uniform wherever encountered along this belt, although, of course, some variation was noted in the percentage of that stained with iron oxide, according as it was found near the surface, or at considerable distance below. There is considerable variation in the percentage of graphite in these pegmatitic dikes, and it will not average over 25 per cent. In some places, however, where the large nodules of graphite were found, the percentage will run as high as 50 or 60 per cent. The graphite is readily

separated from these decomposed dikes, and where it occurs in nodules of an inch or over in size, a product can be obtained by hand-cobbing that is composed of 90 per cent. or over of graphite. No work has been done of sufficient depth so that the unaltered pegmatitic dikes were observed, but in one opening the dikes were observed that were but partially decomposed. If in depth the graphite remains a constant constituent of these pegmatitic dikes, it should be found in a very pure condition as the solid dike is encountered and it should not be a difficult problem at all to make a clean separation of the graphite from the associated minerals of the dike. These pegmatitic dikes are dipping from 30 to 50 degrees northwest and have a general strike a few degrees east of north. They follow for the most part the lamination of the rocks, but sometimes are cutting across them. They vary considerably with width, widening and contracting in short distances.

The occurrence of graphite in pegmatitic dikes is unusual, although it is often found in gneisses and schists, in some places being so abundant in the schist as to form those that are termed graphitic-schists. At only one point was any of the country schist observed that contained any appreciable per cent. of graphite. This was at a small opening on the Will Bentley farm.

The National Graphite Company of Chicago, Ill., are developing a property in Yancey county, but have not as yet done sufficient work to demonstrate what their property contains.

The only graphite mined during 1901 was from the Wake county deposits and amounted to 95 tons valued at $559.25.

COAL.

The coal deposits of North Carolina are confined to the two narrow areas or belts of Triassic sandstone and shales, which cross obliquely the Piedmont Plateau region and are in general parallel to the mountains and seashore. The larger of these is known as the Deep river belt, which in a general way extends along a trough from Oxford in Granville county, southwestward across the State with a width near its central point of some 15 miles, but narrowing very considerably at each end. The coal of the Deep river belt is limited to a region

extending from the southern part of Chatham county 10 or 12 miles into the northern part of Moore county. There are five seams of coal reported in this belt which are separated by black shales and slates, black-band iron ore and fire clay. These seams of coal vary from 6 inches to 4 feet in thickness, but with a probable workable average of 22 to 24 inches. While this cannot be called an extensive coal field, it does offer possibilities of remunerative coal mining. The principal mines being operated are the Cumnock by the Chatham Coal and Coke Company located at Cumnock, Chatham county.

The Dan river belt, which has a width of from 2 to 4 miles and a length of nearly 30 miles in a N. W.-S. E. direction, extending across Stokes and Randolph counties, does not offer as promising possibilities for coal mining as the Deep river belt. The most promising outcrops for coal are those along the line near the wagon road from Walnut Cove to Germanton, Stokes county. The coal-bearing seam at this point is said to have a thickness of from 2 to 7 feet.

The most serious obstacles in mining these coal deposits are the narrowing and pinching of the coal to thin seams; the variation in quality, the wider beds being very apt to be more slaty; the intersection of the coal beds by trap dikes; and the absence of coal from some portions of the area. For these reasons no large prices have been paid for coal lands in this district; and mining should not be undertaken on any considerable scale until the property has been thoroughly tested by boring. The coal is a bituminous of good quality. For all the coal mined in this district, a local State market can be obtained, and the coal should bring a fair price, if it is kept free from slaty material, for the coal has a good reputation. When undertaken conservatively, the mining of this coal should make a profitable but small investment.

The Cumnock mines of the Chatham Coal and Coke Company at Cumnock continue to be the largest producers of coal. A new property of 625 acres is being developed by E. D. Steele of High Point, North Carolina. It is located one mile from Hora Branch, a station on the Durham and Charlotte Railroad in a horse-shoe bend of Deep river, Moore county. The property has been tested by borings and pits. One hole made ¼ of a mile from the northeast boundary of the

property showed the presence of two coal seams, the upper 1 foot 9 inches in thickness, then a seam of slate, and the lower seam 2 feet 8 inches in thickness. Two other holes about ½ a mile southwest of the first showed about the same results. About one-fourth of a mile northwest of the first, another hole was bored which showed 3 feet of soil; 6 feet 10 inches of saprolitic rock; 3 feet of a fire clay; 4 feet 4 inches of slate; and 2 feet 10 inches of good coal. Another property near Eagle Springs, Moore county, is being developed. Samples of coal from this locality were of good quality.

The production of coal in 1901 was 3,723 tons valued at $5,585 as compared with 18,000 tons valued at $22,500 in 1900. The value given for the coal is that obtained for it at the mine. If the work is continued on the Moore county deposits the output should be increased during 1902.

BUILDING STONES.

North Carolina is exceptionally well provided with building stones, which are to be found in abundance in the middle and western counties, and include sandstone, granite, marble, limestone, slate and serpentine, which are taken up in the above order.

Sandstone.

Sandstones are found in the Triassic sandstone formation that forms one belt of rock in Anson, Moore, Chatham, Wake, Durham and Orange counties, and another in Stokes and Rockingham. Dr. Geo. P. Merrill, connected with the United States National Museum, in speaking of the rocks in this belt says: "The narrow belt of Triassic sandstone already mentioned as passing through this State furnishes fine, compact, light and dark reddish-brown stone of a quality not at all inferior to any of that in the more northern and eastern States." The principal points at which brownstone or sandstone is being quarried are Sanford and Carthage in Moore county; Cumnock, Chatham county; and near Durham, Durham county.

In the western part of Wake county there is good desirable sandstone that is accessible to the railroad. In Anson, in the vicinity of Wadesboro, there are a number of good deposits of sandstone, as at the Frank Hammond, Linehan and Wadesboro quarries. The stone

from all these quarries is homogeneous, fine grained and quite compact, and usually of a reddish-brown color, varying in places from gray to a grayish-brown. Compression tests made on a block of this stone from Wadesboro cracked at 8,000 pounds per square inch, and was crushed at 11,163 pounds. Its chemical composition is as follows:

	PER CENT.
Silica (SiO_2)	69.28
Alumina (Al_2O_3) and Iron Oxides (Fe_2O_3 and FeO)	13.84
Magnesia (MgO)	.02
Potash (K_2O) and Soda (Na_2O)	6.43

One noticeable feature of this stone, which is characteristic of most of the stone throughout the belt, is that it hardens considerably on exposure. While it works quite easily when freshly quarried, being split, dressed, and carved with ease, on being exposed for sometime to the air and sun it hardens and becomes very refractory. This is perhaps due to material held in solution (as lime) by the "quarry water," which acts as a cementing material upon the evaporation of the water.

Moore county has a number of localities where a good quality of sandstone can be obtained; one is about one mile northwest and another one mile southwest of Sanford. The McNeill quarry is about three-fourths of a mile from the court-house at Carthage, and contains a good brownstone deposit that can be easily quarried. During 1901 only a few corner stones and steps were quarried on account of the lack of capital to properly equip the quarry and introduce the stone on the market. The quarries of R. E. Carrington & Co. of Sanford are the ones that have been the most extensively operated during 1901. They produce a good building stone that wears well, and has the following chemical composition:

	PER CENT.
Moisture (H_2O)	0.79
Silica (SiO_2)	81.59
Ferric Oxide (Fe_2O_3)	4.38
Alumina (Al_2O_3)	10.81
Lime (CaO)	1.02
Magnesia (MgO)	.33
Potash (K_2O) and Soda (Na_2O)	1.08

The sandstone deposits of Chatham county are in the vicinity of Gulf and Cumnock (Egypt) and there are a number of localities that offer favorable opportunities for quarrying. Near the village of Egypt there is a bluff rising about 30 feet above Deep river that extends at about the same height for half a mile down the river. The color of the stone is a uniform brownish-red, and it is fine-grained and compact. At Gulf there is a fine-grained red-brown sandstone in a bluff that rises about 25 feet above the river.

The sandstone deposits of Durham county are a few miles north and east of the city of Durham. There are also good deposits in the vicinity of Brassfield in the southwestern corner of the county.

Although at the present time there is but little quarrying being done on the sandstone deposits, it is not because they are not extensive or well adapted for building purposes, but for lack of capital. They are capable of being developed on an extensive scale and when the stone is once introduced into the general market it will give satisfaction and there will be considerable demand for it. There are a number of points favorable to quarrying of this sandstone, as the jointage of this Triassic formation, which eliminates the necessity of heavy blasting. Where these joints are not sufficiently close together, light blasts are necessary and the large blocks loosened are afterwards split up into the desired size by means of plugs and feathers driven into a line of holes marking the desired break. Nearly all of the sandstone is rifted parallel to the bedding planes, but it will be found that it splits nearly equally well in either direction.

The production of sandstone in 1901 was valued at $11,682 and was used for building purposes; for road making; and ballast. This is a decrease of $15,528 as compared with the production of 1900, which was valued at $27,210.

Granite.

Granite quarrying is the most extensive of any of the stone trades in the State, and there are numerous deposits of good grades of granite that offer very favorable opportunities for quarrying. Near the city of Raleigh, Wake county, there are a number of quarries that

have furnished a hard, tough, fine-grained, gray gneiss-granite; some of which is favorably located for quarrying and is worthy of investigation. At Wyatt a pink granite is found; and near Rolesville a gray granite occurs abundantly. Twelve miles west of Springhope, Nash county, there are extensive beds of gray biotite-granite of medium grain. In the vicinity of Oxford, Granville county, and Warren Plains, Warren county, a fine light gray granite is to be found that works well. At Greystone, Vance county, a fine-grained gray granite is being quarried. A very pretty mottled porphyritic granite occurs near Lilesville, Anson county. A few miles south of Wilson, Wilson county, there are considerable beds of coarse, red, feldspathic granite, which takes a good polish, closely resembling red Scotch granite.

Building stones are abundant in the higher portions of the Piedmont Plateau region. The more important quarries are in the vicinity of Dunn mountain, Rowan county, 4 to 5 miles east of Salisbury; at Concord, Cabarrus county; Mooresville, Iredell county; and Mt. Airy, Surry county.

The Dunn mountain region is an exceedingly valuable and extensive granite area, which includes Dunn mountain and the adjoining ridge for two miles to the south. It is now being very extensively worked by a number of companies. There are two types of granite obtained from this section; one a medium fine-grained granite of a gray color, and the other, which is similar in texture but has a decidedly pinkish color. The general chemical composition of this pink granite is as follows:

ANALYSIS OF PINK GRANITE FROM DUNN MOUNTAIN, ROWAN COUNTY.

	PER CENT.
Silica (SiO_2)	75.14
Alumina (Al_2O_3)	8.61
Ferric Oxide (Fe_2O_3)	7.42
Manganese Oxide (MnO_2)	Trace.
Lime (CaO)	0.93
Magnesia (MgO)	0.04
Soda (Na_2O)	5.82
Potash (K_2O)	2.57

The Dunn mountain granite makes a good builidng stone and with the present railroad facilities should be operated upon a much larger scale than at present. A more vigorous and extensive system of advertising will create a larger demand for the stone and it can readily enter into competition in price and quality with granite of other States. This is true also of the Mount Airy and other quarries. The Mt. Airy quarries are perhaps the best known of any quarries in the State and have been the most extensively developed. They are located about two miles east of the town of Mount Airy in a solid hill of granite which rises nearly 130 feet above the surrounding valley. The stone is a nearly white granite of uniform grain and texture, and does not exhibit any iron or other injurious accessories. An analysis of this granite gave the following:

ANALYSIS OF GRANITE, MOUNT AIRY QUARRY.

	PER CENT.
Silica (SiO_2)	70.70
Alumina (Al_2O_3)	16.50
Ferric Oxide (Fe_2O_3)	2.34
Pyrite (FeS_2)	0.09
Lime (CaO)	2.96
Magnesia (MgO)	0.29
Potash (K_2O)	2.45
Soda (Na_2O)	4.56

In Davie county there is a very unique but beautiful stone, called "oblicular granite" that is found at Cooloomee, on property belonging to Mr. Frank Hairston. This granite wears well, takes a good polish, and should prove of value as an ornamental stone. The stone consists of a ground mass of quartz and feldspar in which are imbedded around masses of a radiating green augite which are at times more than an inch in diameter.

In the mountain region the principal quarrying has been in the vicinity of Balfour, Henderson county, and Asheville, Buncombe county. At the Balfour quarry, which is nearly one mile southeast of Stony mountain, the stone is a laminated gneiss which at times contains large plenocrysts of feldspar, and while at present it is being used largely for railroad ballast, it is also being cut in dressed

as well as rough building stones and is giving good satisfaction. The Corn quarry, about one mile northeast of the Balfour, is a nearly white stone which makes a very attractive decorated or front building stone, and is being quarried on a small scale.

There has been a constant increase in the production of North Carolina granite in the past few years and a considerable demand is arising for it outside the State, but which should be very much larger. The total value of all the granite produced in 1901 was $264,402 as compared with $257,962 in 1900.

In the following table is given the different uses for which the granite has been used:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901.

Uses.	Value.
Building and monumental purposes	$ 108,574
Paving blocks	10,662
Curbing and flagging	56,245
Crushed stone for road-making and railroad ballast, etc.	89,425
Total value	$ 264,906

Marble.

Marble occurs very extensively in Swain and Cherokee counties and is associated with the talc deposits described on page 66. The marble varies in color from white to pinkish and bluish. While a great deal of the marble has been too much broken in connection with the folding and general up-lift of the rocks of the region to be available as a building stone, there are, however, a number of deposits in which it is of considerable economic importance. The Kinsey quarry some four miles southwest of Murphy is the only one that has been operated during 1901. The marble here is of a pinkish-white and bluish-gray color to white, and of a uniform texture. There is a very promising deposit near Andrews, Cherokee county, on the property of Mr. C. N. Hickerson, across the river from the railroad depot. The deposit here has been tested by boring at a number of places, and it was found to exist in quantity and to be suitable for

building and ornamental purposes. It is white and bluish-gray in color and some has a very pretty mottled appearance. It is fine-grained and compact, and the white variety gives indications of being available for a statuary marble. Below are given partial analysis of the pinkish marble (1) and bluish marble (2) from the Kinsey quarry and the white marble (3) from the Hickerson deposit:

ANALYSIS OF MARBLE FROM THE KINSEY AND HICKERSON DEPOSITS.

	PER CENT.		
	1	2	3
Insoluble residue	2.90	2.80	1.58
Lime (CaO)	49.10	52.30	32.42
Magnesia (MgO)	3.67	0.50	19.58

The first two represent lime marble and the latter a dolomitic marble. It is very probable that the sample from the Hickerson property was near the contact of the talc deposits or quartzite, for it has been observed that all the marble in proximity to the contact that has been examined was dolomitic in character, but further away from the contact it was more of a lime marble.

Four miles a little north of east of Murphy a little development work has been done during 1901 and a quarry has been opened which it is expected will be producing during 1902. This work has been done by the National Marble Company of Murphy, North Carolina.

In Swain county one of the most promising deposits is the Hewitt quarry, near Hewitt station on the Southern Railroad, and is favorably located for quarrying. Tests made upon this marble have shown it to be of very good quality and well adapted for building, both for outside and inside purposes; and it has a high resistance to disintegration by frost. A partial analysis of this marble is as follows:

	PER CENT.
Silica (SiO_2)	0.95
Lime (CaO)	52.33
Magnesia (MgO)	1.69
Carbonic Acid (CO_2)	43.20

This shows the stone be a very pure lime marble.

A very extensive deposit of a dolomitic marble occurs about 10 miles north of Marion, McDowell county. It is fine-grained and in color is usually white, but at times it is distinctly blue. Portions of the stone are well suited for building or ornamental purposes. Its chemical composition is indicated in the partial analysis given below:

ANALYSIS OF MARBLE FROM McDOWELL COUNTY.

	White Marble.	Blue Marble.
	per cent.	per cent.
Silica (SiO_2)	0.60	1.40
Lime (CaO)	30.29	29.23
Magnesia (MgO)	21.22	19.58

Nearly all of these marbles would burn to excellent lime, and as nearly all the lime used in North Carolina is imported, the waste product in quarrying should be utilized for this purpose.

There was no production of marble reported in 1901. Thus far there has been practically no attempt made to utilize the waste marble obtained in quarrying, either for burning to lime or for any other purpose. The National Marble Company expect to utilize their waste marble by making lime.

Limestone.

Limestone is found quite widely distributed in North Carolina and has been quarried to some considerable extent for making lime and also for building and paving purposes. Besides the marbles (metamorphosed limestones) of Cherokee and Swain counties, limestone is found quite extensively in Henderson, Transylvania, Madison and Wake counties. The limestone in Henderson and Transylvania counties is from bluish to a nearly pure white in color and is partially metamorphosed. It occurs in the valley of the French Broad river from near Mill river to above Brevard. Limestone of fair quality is found in the vicinity of Hot Springs, Madison county. The Wake county deposits are in the vicinity of Raleigh.

In the eastern counties, especially New Hanover, an impure lime-

stone occurs that offers possibilities for burning to lime or for use in the manufacture of cement.

The larger proportion of the lime used in North Carolina is brought in from Tennessee and Virginia, and the manufacture of lime from the North Carolina limestone deposits offers a very promising field of investment, for the best quality of lime can be made from the limestone from the western counties, and if the limestone deposits of the eastern counties will make a good lime or cement, they offer good shipping facilities for the manufactured product.

The production of lime in 1901, valued at $11,963, was obtained from New Hanover, Pender, Wake, Henderson, and Transylvania counties; and was used for the following purposes:

USES OF LIMESTONE MINED IN 1901.

Uses.	Value.
Building purposes	$ 237.50
Made into lime	3,688.00
Road materials, curbing, etc.	4,668.00
Total value	$ 8,356.50

Slate.

Slate of good quality is found in the vicinity of Egypt, Pittsboro, and Goldston, Chatham county, and near Albemarle, Stanly county. It has also been found in Durham and Alamance counties, but its actual value has not been determined. There was no production of slate during 1901.

Serpentine.

Deposits of massive serpentine of a light to dark-green color have been found at a few places in North Carolina and they are in nearly every particular identical with those of Maryland, Delaware and Pennsylvania, which have been worked for building purposes. As far as can be judged from what can be seen of the deposits, they are as well adapted to architectural purposes as those of the Northern States.

The stone is compact and worked easily, but at the same time it is tough and wears well. It takes a fine polish and the dark green and mottled varieties give a very rich effect, while the lighter colors, though somewhat peculiar, are not unpleasing. It is used as both an exterior and interior building stone, but it is better suited and much more effective as an ornamental stone for interior decorations.

There are a number of outcrops of serpentine in Buncombe county between Weaversville and Leicester in a formation that crosses the French Broad river a mile below Alexander. The serpentine here is of first-class quality and its nearness to the railroad makes it a very promising deposit for quarrying. Other deposits which are as large and of about the same quality are on Paint Rock of Ivy creek, Madison county, and on Bald creek, Yancey county. These are, however, at the present time too far from railroad transportation. Another deposit that is worthy of investigation is the one in which the asbestos occurs that is described on page 97. At the bottom of the cut referred to, the serpentine was of good color, hard and compact, and takes a good polish. It is within three-fourths of a mile from the railroad, and water-power is available for sawing the stone.

Thus far no attempt has been made to utilize the North Carolina serpentines, but the Buncombe county and Wilkes county deposits are worthy of further investigation as to the actual amount of good work that they are capable of producing. When once this stone has been to be marketed, there is little doubt but that the demand for it will rapidly increase.

CLAY.

Under this head are included all the clays of whatever character, from the purest kaolin to the most impure brick clay, that have been used in any way for commercial purposes. All clays are mixtures of mineral kaolinite with more or less quartz and other mineral elements (silicates) oxides, etc.), possessing usually some plasticity when mixed with water; and being capable of becoming converted into a hard, rock-like mass when subjected to a high heat. An absolutely pure clay would be composed simply of this mineral kaolinite and where there are nearly pure masses of this they are known as

kaolin, and they form the more valuable clay deposits. As kaolinite is not an original mineral, so all our clays are the result of the alteration or decomposition of other minerals, which are for the most part feldspars. These feldspars sometimes occur in nearly pure large masses, as in some pegmatitic dikes, the alteration of which have formed some of the finest beds of kaolin. They also form one of the principal constituents of a large class of rocks, as granites, gneisses, etc., which in their subsequent alteration and disintegration have formed beds of clay. This change that takes place in the minerals of the rocks is due largely to percolating waters containing oxygen and carbon dioxide which are able to penerate into the most remote cracks and crevices of the rocks and thus under pressure, attack the different minerals. In the case of these feldspars, which are essentially potassium and sodium aluminum silicates, the alkalies (sodium and potassium) are removed in the form of carbonates, while the remaining alumina and silica are hydrated, forming the mineral kaolinite. Where the feldspar occurs in large vein-like masses, the result would be beds of nearly pure kaolin, but where it is a constituent of some large rock mass, the resulting product is one of the impurer clays.

This resultant clay materials may be deposited at or very close to the place where they originated, when they are known as residual clays; or they may have been washed down and deposited in ponds, lakes and seas as sediment, with the addition of other mineral substances, when they are known as sedimentary clays. The residual clays are of a sandy nature, and because of their porosity more care is required in burning them. They often contain many angular grains and fragments of wholly or partially decomposed mineral matter; and the banded structure of the original rock from which the clay originated can often be observed extending up into the clay. Residual clays are to be found all over the Piedmont Plateau and mountain regions of the State, and their thickness depends upon the depth to which the alteration of the rocks from which they have been derived, has extended; and also on the slope of the land.

Sedimentary clays generally make a smoother, denser brick, and one which burns at a lower temperature. These are commonly found

underlying the terraces along rivers, or else in the bottoms of the valleys, where they represent the remains of deposits of sediment in old lakes and ponds. These are found in the Coastal Plain region as well as the Piedmont Plateau and mountain regions.

North Carolina is well supplied with clays of all descriptions, and especially of residual clays, and the great quantity of these has had a somewhat injurious effect upon the clay industry for the reason that in the erection of many cotton mills and other buildings, the contractor has tried to utilize the nearest bed of residual clay (the more siliceous the better he likes it) in the manufacture of the brick for the buildings. Sometimes a good brick would be made, more often a poor one. This is due sometimes to a poor clay, but it is more often due to the contractor trying to make the brick at a minimum amount of labor and expense. Frequently brick are used, the contents of which will hardly stick together. The clays for making common building brick and pressed brick are just as important and should be given as much care as stoneware clay and china clay (kaolin).

The clays can be treated to advantage by taking them up under the following heads: Kaolin, or China Clay; Pottery Clay; Fire and Pipe-clay; and Brick-clay.

Kaolin or China Clay.

Kaolin has been found in a number of widely separated localities in North Carolina, especially in the mountain region, in the form of extensive veins or dikes which were formerly composed largely of feldspar, but which have decomposed from the action of atmospheric agencies and formed this clay. Associated with the kaolin there is always some quartz and mica which were original constituents of the dike or vein. The best kaolin deposits are those in which the feldspar formerly largely predominated in the dike. These dikes vary considerably in size, ranging from a few inches to several hundred feet in thickness and up to several hundred yards in length. They are usually parallel to the schistosity of the crystalline rocks. At the present time kaolin is being mined at a number of places in the vicinity of Webster, Sylva and Addie, Jackson county, and Bryson

City, Swain county. The kaolin deposit that has been worked the most extensively is the one near Webster and known as the Harris mine. This has been worked to a depth of 120 feet, below which point the material becomes harder and does not permit of cheap mining operations. The dike in which this mine occurs has a thickness of nearly 200 feet and has been traced across the country for a distance of more than half a mile. Similar but smaller kaolin dikes are common throughout the Mountain and Piedmont plateau regions, but in order to be successfully worked they must be near railroad facilities.

There is a promising deposit of kaolin near West's Mill, Macon county, on the land of Geo. Brindel. It is of remarkable whiteness; burns to a pure white color; is very fine-grained, free from grit, and shows a few scattered scales of mica. There is also a promising prospect near Liberty Church, Cowee valley. These deposits are at the present time too far from railroad facilities to be of commercial value, but with the advent of the proposed railroad from Talulah Falls, Georgia, to Franklin, Macon county, these deposits will be available. The kaolin deposit on the property of the National Abrasive Manufacturing Company near Hall, Jackson county, has been developed to a slight extent and the clay is of a good quality. It gives indications of occurring in quantity, and as it is not far from the railroad, should make remunerative mining. Near Bostick Mills, 14 miles north of Rockingham, Richmond county, there are extensive deposits of kaolin, which are near railroad transportation and are well worthy of further investigation. There are promising deposits of kaolin that are known to occur 4 miles west of Troy, Montgomery county; near North Wilkesboro, Wilkes county; and in Beaver Dam township, 2 miles southwest of Canton, Haywood county, on land belonging to J. B. Rhodarmer, which is of good quality and apparently in quantity as shown by a shaft 18 feet deep that has been sunk on the deposit.

The most noticeable change that has occurred in the kaolin industry in the State during 1901 is the opening of the mines in Swain county and the erection of a plant for cleaning and preparing the kaolin for market. The Harris mine is still the largest producer of

kaolin in the State and is located near Webster, Jackson county. There was a considerable increase in the production of kaolin in 1901 which was 15,575 tons valued at $119,171.83 as compared with 7,000 tons valued at $62,440 in 1900. This increase is partially due to the opening of the Swain county mines. The above figures are for both the washed kaolin prepared for market, and the raw kaolin sold during 1901. There is a good demand for this North Carolina kaolin at the present market price of $8.50 to $9.50 per ton, numerous inquiries being received for information regarding the location of kaolin deposits.

The kaolins of North Carolina, where they contain less than one per cent. of ferric oxide, are well adapted to the manufacture of white earthenware or china; and also of the best grades of porcelain. Where the percentage of ferric oxide is from 1 to 2 per cent., the kaolin could probably be used for the lower grades of white earthenware, while those containing from 2 to 2½ per cent. of this oxide could perhaps be used to advantage by mixing with fire clays in the manufacture of refractory apparatus.

Pottery Clays.

There has been but little development of the pottery industry in North Carolina, and although there are 40 or more potteries in the State, they are all small and for the most part are making inferior grades of ware. By far the larger proportion of the earthenware and stoneware used in the State is imported, while it should be manufactured at home. There are plenty of clays suitable for this purpose, which are the finer aluminous sediments underlying the river terraces and which are found in many of the broader valleys, the better clays being usually found near the shore line of the terraces. In using the term pottery clay, it is meant to include those clays that are used to make the lower grades of earthenware and stoneware, the higher grades of pottery being made from kaolins. In the manufacture of common earthenware, which would include flower-pots, almost any red burning plastic clay that permits turning on the potter's wheel and burns to a good red without vitrifying, can be used. In the manufacture of stoneware a better quality of clay is required

and the requisites for such clays are that they should possess good plasticity in order to permit molding or turning without cracking; their tensile strength should be not less than 125 to 150 pounds per square inch; they should not shrink excessively in burning; and should burn to a dense vitrified body, if possible, at a temperature of 2,000 degrees to 2,100 degrees F. They should permit of rapid drying and be as smooth and free from grit as possible. Such clays are found underlying the terraces along the Catawba river north of Morganton and Mt. Holly, Burke county, and near Blackburn and Catawba, Catawba county; the South Fork of the Catawba river, just north of Lincolnton, Lincoln county; the Yadkin river near Wilkesboro, Wilkes county; and Elkin, Surry county; including the old terraces of the Deep river near Ulah and Why Not, Randolph county. In the eastern part of the State along the Cape Fear river near Fayetteville, Cumberland county; the Neuse river near Goldsboro, Wayne county; and Contentnea river, a tributary of the Neuse, in Wilson county, near Wilson, are similar deposits of clay.

There have been 43 pottery manufacturers who responded to inquiries regarding the amount of pottery made by them in 1901 and they reported a total production of $22,495, which is an increase of $3,632 over the production of 1900, which was valued at $18,863. The production of 1901 was divided as follows: For earthenware, $4,490; stoneware, $17,453; and decorative ware, smoking pipes, etc.; $552, as compared with $1,937 of earthenware; $16,498 of stoneware; and $428 of decorative ware in 1900.

While there has been this increase in the value of the production of pottery in 1901, it does not begin to represent the value of what should be produced in the State. With the application of the improved methods, with more care, and by using better material for glazing the ware, the North Carolina potter would be able to put a far better grade of pottery on the market, which would sell at a correspondingly increased price.

In the following table is given a statement of the value of the pottery products by counties and of the value of the earthenware, stoneware and decorative ware made in each county:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA BY COUNTIES IN 1901.

County.	Earthenware.	Stoneware.	Decorative Ware, etc.	Total.
Buncombe	$ 220	$ 3,100	$	$ 3,320
Catawba		2,540		2,540
Chatham		2,700		2,700
Cumberland	60			60
Johnston	525	1,700		2,225
Lincoln	2,500	2,000	25	4,525
Randolph	860	3,173	200	4,233
Union	325	1,040	27	1,392
Warren			300	300
Wilkes		1,200		1,200
Total value	$ 4,490	$ 17,453	$ 542	$ 22,495

As is seen from the above table, the pottery products are confined for the most part to stoneware and that the amount of decorative ware or fancy ware is extremely limited.

Fire Clay and Pipe Clay.

There are but few known occurrences of deposits of fire clay in North Carolin. The main point desired in a fire-clay is a refractory character and it should also possess good plasticity, low shrinkage, and should be unaffected by a temperature of 2,500 degrees F. (although brick are sold as fire brick which are affected by a temperature of 2,100 degrees F.). Such clays are known to occur at Pomona, Guilford county; Grover, Cleveland county; and Emma, Buncombe county. A clay has also been reported from Cherokee county, about 4 miles east of Murphy, that is suitable for making fire brick and also one near Wilson's Mills, Johnston county. The fire clay from Emma, N. C., has recently been tested by Dr. Heinrich Ries, who heated it to a temperature of about 3,000 degrees F. and it only showed the very finer particles to have been attacked and viscosity occurred at a temperature of 3,250 degrees F. These tests show the clay to have qualities that adapt it for manufacturing into fire brick. The company

operating the clay deposits at Emma expect to increase their plant so that they can manufacture fire brick.

There were not many fire brick made during 1901, and they were valued at $550, as compared with a production valued at $714 in 1900.

The requisites desired in clays for the manufacture of sewer pipe are that they should be plastic to permit molding without cracking; have a tensile strength of 125 to 150 pounds; burn to a dense, hard, impervious body of a red or deep red color, and dry and burn with rapidity without the ware warping or cracking. The principal manufacturers of sewer pipe and tile is the Pomona Terracotta Company at Pomona, Guilford county, North Carolina, and they have been constantly increasing the production of their plant. This plant illustrates what can be done with the clays of North Carolina when they are worked on a large scale and by improved methods. The value of the total production of sewer pipes, tile, etc., produced in 1901 was $55,745.05 as compared with $54,796 in 1900.

Brick Clay.

There are in the greater number of the counties throughout North Carolina clay deposits that are suitable for the manufacture of brick, and they consist of both residual and sedimentary clays. These clays vary in composition both with the character of the rocks from which they have been formed and with the extent to which the materials and the original rocks have been separated by the sorting action of water in transporting these from one place to another. They are usually of a reddish or yellowish color, due to the presence of iron oxide. Although there is a great deal of work being done on the brick clay deposits throughout the State, it is for the most part confined to the manufacture of common brick and there is but little attention being given to the manufacture of pressed, front, or fancy brick. This is not because the clays are not adapted to the manufacture of these brick, for there are many clay deposits that are capable of being made into an excellent pressed or front brick, as those near Asheville, Buncombe county, Wilkesboro, Wilkes county, Goldsboro, Wayne county, etc. Many of these places are at the intersection of several

lines of railroad so that the products would have good railroad facilities for shipment. When it is considered that the larger proportion of the pressed and fancy bricks used in this State are now being imported, it will be seen that there is good opportunity for the development of this branch of the clay industry in North Carolina. Even in the manufacture of common brick the industry is not what it should be, for in many cases the crudest methods are used in their manufacture, and sufficient care is not taken in burning them, so that the result is often a brick of poor quality that will not stand shipment. This also means that a lower price is obtained for the brick. With such favorable opportunities as are offered for making brick in many places in North Carolina, there should be a large increase in their production, especially of fancy and pressed brick; and in a better quality of common brick.

The number of brick made in North Carolina during 1901 was 135,566,570 valued at $710,680.84, this being an average value of $5.22 per thousand. This is a decrease of 13,051,430 brick, and of $30,922.84 in value as compared with the production of 1900, which was 148,618,000 brick valued at $741,602. The lowest value recorded for brick was $2.33 per thousand and the highest $10, except in one instance, when $20 per thousand was reported for a special vitrified brick. The highest price recorded as having been received for common brick was $8 per thousand. There were in all 231 manufacturers engaged in making brick during 1901, who made replies regarding their production. In the following table is given the total number of and value of brick produced in 1901 by counties and also the number and value of common brick, pressed brick, and vitrified or paving brick.

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1901.

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified Brick.	Value.
Alamance	4,408,000	$ 21,665.00		$		$
Anson	600,000	3,000.00				
Beaufort	1,695,000	10,480.00				
Bertie	575,000	2,850.00	30,000	240.00		
Bladen	450,000	2,250.00				
Buncombe	2,084,250	10,594.80	200,000	2,400.00		
Burke	1,075,000	4,600.00	25,000	200.00		
Cabarrus	3,050,000	15,250.00				
Caldwell	1,570,000	6,410.00				
Carteret	450,000	2,425.00				
Catawba	845,000	4,050.75				
Chowan	1,000,000	7,000.00				
Cleveland	1,500,000	8,100.00				
Columbus	2,400,000	12,450.00				
Craven	3,250,000	16,750.00				
Cumberland	1,500,000	7,500.00				
Davidson	1,560,000	7,400.00				
Davie	2,500,000	15,000.00				
Duplin	237,000	1,306.00				
Durham	8,425,000	40,275.00	10,000	100.00		
Edgecombe	3,465,000	20,270.00				
Forsyth	10,492,000	48,206.00				
Franklin	500,000	3,500.00				
Gaston	3,150,000	15,630.00				
Gates	100,000	425.00				
Granville	1,250,000	6,250.00				
Greene	1,101,086	6,653.48				
Guilford	10,238,000	53,025.75	170,000	1,700.00	100,000	750.00
Halifax	2,160,000	12,460.00	100,000	1,000.00		
Harnett	1,000,000	5,600.00				
Haywood	500,000	2,500.00				
Henderson	2,950,000	14,325.00				
Iredell	1,907,000	8,885.00				
Jackson	3,000	18.00				
Johnston	1,435,000	8,350.00				
Lenoir	2,500,000	13,000.00				
Lincoln	450,000	2,250.00				
McDowell	1,100,000	6,300.00				
Martin	55,000	328.00				
Mecklenburg	7,485,000	41,062.00				
Montgomery	50,000	20.00	190,000	1,130.00		
Moore	1,635,050	10,220.00				
Nash	6,420,000	24,100.00				
New Hanover	1,000,000	3,000.00				
Orange	825,000	4,345.00				
Pasquotank	1,700,000	10,200.00	25,000	250.00		
Person	600,000	3,000.00				
Pitt	320,263	1,794.73	100,000	1,000.00		
Randolph	697,571	2,942.02	25,000	150.00		
Robeson	1,545,000	8,689.00				
Rockingham	860,000	3,850.00				
Rowan	3,760,000	18,400.00				

County.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified Brick.	Value.
Rutherford	1,602,000	$ 7,783.00				
Sampson	425,000	2,350.00				
Scotland	1,000,000	5,000.00				
Stanly	300,000	1,500.00			50,000	500.00
Surry	1,565,000	7,125.00	90,000	750.00		
Transylvania	187,000	875.00				
Union	2,304,000	11,415.00				
Vance	100,000	700.00				
Wake	3,977,400	22,357.31	50,000	500.00		
Warren	150,000	750.00				
Washington	300,000	1,800.00				
Wayne	7,550,000	39,450.00			10,000	200.00
Wilkes	585,000	2,865.00	30,000	300.00		
Wilson	2,950,000	17,700.00	50,000	400.00		
Yadkin	63,000	315.00				
Total	134,441,570	697,860.84	1,095,000	10,220.00	180,000	1,650.00

Of the 97 counties in North Carolina all but 31 reported some production of brick. The largest number of brick were made in Guilford county and amounted to 10,238,000 valued at $53,025 or $5.07 per thousand. Jackson county produced the smallest number, which amounted to 3,000 bricks valued at $18.

In the following table are given the value of the clay products produced in 1900 and 1901:

VALUE OF CLAY PRODUCTS OF NORTH CAROLINA IN 1900 AND 1901.

	1900.		1901.	
	Quantity.	Value.	Quantity.	Value.
Common brick	148,177,000	$ 737,577.00	134,441,570	$ 697,860.84
Pressed brick	441,000	4,025.00	1,095,000	10,220.00
Vitrified brick			180,000	1,650.00
Fire brick		714.00		550.00
Earthenware		1,937.00		4,490.00
Stoneware		16,498.00		17,453.00
Decorated ware		428.00		552.00
Sewer-pipe, etc.		54,796.00		55,745.05
Kaolin	7,000 tons	62,440.00	15,575 tons	119,171.83
Fire clay			33½ tons	100.00
Total value		$ 878,415.00		$ 907,789.72

In the aggregate the clay industry in the State becomes an important one, but there is still much room for improvement, and not only should the actual production be greater, but still more so should the value of the production increase. The above statistics regarding the clay production of the State do not represent the entire production, for there have been a number of the producers of clay products that have been very reticent in responding. This has not only caused the statistics regarding clay products of the State to appear lower than they should, but it also reduces the value of the mineral production that is given under the head of the different counties. It is to be hoped that another year those interested in the development of the different mineral products of the State will be more prompt to send in their statistics.

OTHER ECONOMIC MINERALS.

There are a number of minerals that are found in quantity in North Carolina that have a commercial value, but are not being mined at the present time. There are still others which give indications of occurring in quantity and are worthy of further investigation. A brief description is given of the more important of these minerals, including their uses, value, modes of occurrence, etc.

Chromite or Chromic Iron Ore.

Chromite is a mineral that usually occurs massive with a fine granular to compact structure. When crystallized it is usually in small octahedrons. It is brittle, breaks with an uneven fracture and has a hardness of 5.5, which is about the same as hard steel. In color it varies between iron-black and bluish-gray and has a submetallic to metallic luster. Its theoretical chemical composition is represented by the formula $FeO\ Cr_2O_3$, a combination of chromium sesquioxide and iron protoxide; but it is usually found that a portion of the iron is usually replaced by varying amounts of magnesium and the chromium by aluminum.

The uses of this mineral are in the production of the salts chromate and bi-chromate of potash which are used particularly in dyeing and in the manufacture of coloring pigments; in the manufacture of ferro-chromium alloys which are used very extensively in the manu-

facture of chromium steel. The mineral itself is being used in the manufacture of brick for use in basic open-hearth furnaces. It is also being used directly for linings of various furnaces and where used has given satisfaction. In this connection it is used as a lining for furnaces for smelting copper and this should make the North Carolina ores valuable for the Ducktown, Tennessee deposits and the Gold Hill, Ore Knob, and Blue Wing deposits of North Carolina.

The value of a chrome ore depends upon the percentage of chromic oxide (Cr_2O_3) that it contains, standard ore containing 50 per cent. of this oxide. For every unit above 50 per cent. there is an increase in value of 75 cents to $1 per ton; but below 50 per cent. there is a much greater deduction per unit. Ores low in silica are the more valuable, and even when they contain but 45 per cent. of the chromic oxide they find a market if they are low in silica.

With the exception of alluvial deposits, chromite has been found only in peridotites and allied igneous basic magnesian rocks or in serpentines which have resulted from the alteration of these rocks. In the alluvial deposits at the base of these rocks there is usually a considerable amount of chromite in crystals and small particles and in certain localities they have been observed in sufficient quantity to constitute a chrome sand ore. In the North Carolina peridites chromite occurs more commonly in grains or crystals and also in embedded masses near the boundary of the lenticular masses of these rocks. The general character of the chrome ore is nearly uniform throughout the entire area, being very hard and compact, though often of a fine granular appearance, and there is but little that is at all friable. The masses of chromite are usually very free from seams containing peridotite or its alteration product serpentine and a high grade ore can usually be obtained by hand-cobbing.

While chromite is found almost universally associated with the peridotites of North Carolina, it is only in a few localities that it occurs in quantity and a brief description of these is given below. One of the most promising deposits in the State is in Yancey county at Mine Hill on Mine Fork of Jack's creek, alongside of the Bakersville road, 5 miles north of Burnsville, the county-seat. The ore occurs in a large peridotite formation which outcrops on both sides

There are a number of localities in North Carolina where the chrysotile variety of asbestos has been found, the most promising of which are in the vicinity of Glennville and of Sapphire, Jackson county, near the mouth of Squirrel creek of North Toe river, along the western slopes of Rich mountain in Watauga county; on Elk creek in Ashe county; and near North Wilkesboro, Wilkes county. At these localities fiber of fair length and fineness has been found which warrant further investigation.

The deposit near North Wilkesboro is within ¾ of a mile of the railroad and occurs in a serpentine formation that is from 75 to about 200 feet in depth and can be traced in a general N. W.-S. E. direction for nearly 600 yards. The deposit has been worked by means of an open cut 100 feet long which was made on the land of Mr. J. B. Church. The cut varies in depth from 1 to 35 feet and near the surface the serpentine encountered was badly decomposed and altered, but at lower depths a compact, dark-green rock was found. This harder rock is similar to a bold outcropping of the serpentine that occurs on a low hill about 300 yards a little east of south of his cut. A similar outcrop of serpentine was observed on the summit of a hill 200 yards nearly north of the cut. In nearly all of this serpentine small seams of the chrysotile asbestos were observed that varied in width from a quarter of an inch to some that were encountered in the bottom of the cut that were nearly two inches wide. These seams run at all angles through the rock and, as the unaltered serpentine was encountered, the asbestos became of better quality. Sufficient work has not been done to demonstrate the actual value of this property as a source of asbestos, but it is worthy of further investigation.

The amphibole variety of asbestos has been found in quantity at a number of localities; near Plumtree, Mitchell county, and on Ellijay creek, Macon county, but on account of their distance from the railroad they have not been able to be worked. There is a very promising locality of this variety of asbestos found on Tryon mountain, Polk county, about 1½ miles west of Skyuka, which has been traced across the country for nearly a mile. It occurs apparently in a series of pockets, one of which was opened and measured nearly 100 feet in width. It is of fair quality and large masses have been taken out

in width. It is of fair quality and large masses have been taken out where the fiber was from 10 to 15 inches in length. This property is owned by Mr. D. Stern, Lynn, North Carolina.

Zircon.

Zircon, a zirconium silicate ($ZrSiO_4$), is commonly found in square tetragonal prisms terminated by the pyramid, and is usually of a grayish, light brown to a reddish-brown color. It is 7.5 in hardness and has a specific gravity of about 4.65. It is commonly found sparingly in crystalline rocks, especially granular limestone, chloritic and other schists, gneiss, syenite and granite. It has also been found associated with some of the iron ores. The use that has been made of this mineral is for a source of zirconia (ZrO_2), which is used in the manufacture of cylindrical hoods or mantles for certain of the incandescent gas lights. At the present time there is but little of this mineral that is being mined except for experimental purposes. There is one noted locality in North Carolina where this mineral has been found in quantity and this is in the vicinity of Zirconia, Henderson county. The zircons occur in what is apparently a decomposed pegmatitic dike about 100 feet wide and with a strike nearly 50 degrees east. The upper portion of the dike is badly kaolinized which permits an easy separation of the zircon which was done by hydraulic processes. As the vein became more solid it is more difficult to separate out the zircon. They are, however, readily detached from the feldspar matrix as this is broken up. There are two mines on these deposits, one the Jones zircon mine half mile west of Zirconia railroad station and the other the Freeman zircon mine which is one mile west of the Jones. From the work done at these mines, it seems very probable that if the demand does arise for zircon in quantity, that a constant supply can be obtained from these mines. Another promising locality for zircon is near New Stirling, Iredell county.

During 1901 there were about 75 pounds of this mineral valued at $15 sold for experimental purposes.

SUMMARY.

The statistics of the mining industry for 1901 show a decided increase in the production of those minerals that are principally mined in the State; and those which show a less production than of the year

before are those whose production is necessarily limited, either because of location or small deposits. The past year has not only seen more values taken out of the mineral deposits of the State than for a number of years past, but has also seen more money invested in thorough and competent development work than ever before. This means that the mineral production of the State will increase at a rapid rate during the next year or two; and with the successful development and operation of the mines it will mean an additional impetus to bring capital into the State.

Some of the most promising mining propositions that are awaiting investigation and the investment of capital are the clay deposits, which are suitable for the manufacture of pressed and fancy brick and pottery; the large deposits of low grade gold ores, to be treated by the cyanide process; graphite deposits; the granite, marble, sandstone and serpentine deposits; and the corundum mines.

In the table below is given the total mineral production of the State for the years 1900 and 1901:

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS 1900 AND 1901.

Mineral.	Value.	
	1900.	1901.
Gold	$ 46,653.00	$ 60,410.71
Silver	15,986.00	34,023.64
Copper	41,600.00	76,900.00
Iron	42,000.00	4,997.00
Pyrite	14,625.00	32,000.00
Corundum	36,840.00	48,840.00
Garnet	18,000.00	43,000.00
Mica { Sheet	65,200.00	79,849.00
Mica { Scrap	36,262.00	14,200.00
Quartz	None.	7,500.00
Barytes		22,615.00
Monazite	48,805.00	59,262.00
Talc	42,000.00	77,974.00
Gem minerals, etc.	12,020.00	24,245.00
Graphite		559.25
Coal	22,500.00	5,585.00
Building stones	285,172.00	284,744.00
Kaolin	62,440.00	119,171.83
Clay products	815,975.00	788,617.89
Total value	$ 1,604,078.00	$ 1,779,109.32

It will be noticed in the above table that in most cases there has been a decided increase in the production of those minerals for which North Carolina is especially noted, as talc, monazite, kaolin, etc., and that the decrease is for the most part in those minerals, the production of which is not expected to amount to very much in this State. This indicates a healthy condition of the mining industry and should give considerable impetus for a greater amount of mining and development work in 1902, for there is an increasing demand for many of these minerals that are being mined.

This mineral production of 1901 was obtained from 75 counties and the value of this production for each county is given in the table below. The clay products are given separately from the rest of the mineral production whose total value is given.

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA IN 1901.

County.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	County.	Mineral Production, including Kaolin.	Clay Products, except Kaolin.
Alamance	$ 400.00	$21,965.00	Jones	$	$
Alexander	175.00		Lenoir		13,000.00
Alleghany	720.00		Lincoln	100.00	6,275.00
Anson	1,800.00	3,000.00	McDowell	37,074.00	6,300.00
Ashe			Macon	58,180.00	
Beaufort		10,480.00	Madison	14,795.00	
Bertie		3,162.00	Martin		325.00
Bladen		2,250.00	Mecklenburg	32,149.00	41,062.00
Brunswick			Mitchell	42,835.06	
Buncombe	15,090.01	15,469.85	Montgomery	2,000.00	200.00
Burke	24,282.00	4,800.00	Moore	18,796.00	10,220.00
Cabarrus	22,426.71	15,250.00	Nash	100.00	24,100.00
Caldwell	70.00	6,410.00	New Hanover	4,668.00	3,000.00
Camden			Northampton		
Carteret		2,425.00	Onslow		
Caswell			Orange		4,345.00
Catawba		6,710.00	Pamlico		
Chatham	5,585.00	2,700.00	Pasquotank		10,450.00
Cherokee	27,500.00		Pender	600.00	
Chowan	7,00	0.00	Perquimans		
Clay	9,00	0.00	Person	47,000.00	3,000.00
Cleveland	17,532.00	8,100.00	Pitt		1,794.73
Columbus		12,450.00	Polk	300.00	
Craven		16,750.00	Randolph	20,165.00	7,377.02
Cumberland		7,560.00	Richmond		
Currituck			Robeson		8,689.00

County.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	County.	Mineral Production, including Kaolin.	Clay Products, except Kaolin.
Dare	$	$	Rockingham	$	$ 3,850.00
Davidson	2,500.00	7,400.00	Rowan	126,438.15	18,400.00
Davie	15,00	0.00	Rutherford	8,989.64	7,783.00
Duplin		1,306.00	Sampson		9,100.00
Durham		40,275.00	Scotland		5,000.00
Edgecombe		20,270.00	Stanly	2,660.16	2,000.00
Forsyth	3,906.00	48,206.00	Stokes		
Franklin		3,500.00	Surry	88,6	54.00
Gaston	42,279.50	15,630.00	Swain	40,115.00	
Gates		425.00	Transylvania	1,440.00	875.00
Graham			Tyrrell		
Granville		6,250.00	Union		12,807.00
Greene		6,653.48	Vance	18,700.00	700.00
Guilford		110,974.00	Wake	21,034.25	22,357.31
Halifax		13,460.00	Warren		1,050.00
Harnett		5,600.00	Washington		1,800.00
Haywood	13,124.00	2,500.00	Watauga		
Henderson	13,169.43	14,325.00	Wayne		39,450.00
Hertford			Wilkes		5,465.00
Hyde			Wilson		17,700.00
Iredell	70.00	8,885.00	Yadkin		315.00
Jackson	163,641.93	18.00	Yancey	33,995.00	
Johnston		10,575.00			
			Total value	$ 990,491.43	$ 788,617.89

As is seen from the above, of the 75 counties reporting their mineral production, there were but 40 that reported anything besides clay products. The following 18 counties, Ashe, Brunswick, Camden, Caswell, Currituck, Dare, Graham, Hertford, Hyde, Jones, Northampton, Onslow, Pamlico, Perquimans, Richmond, Stokes, Tyrrell, Watauga did not report any production of any mineral whatever during 1901.

Jackson county leads the list in the value of the mineral production (except clay products), their value being $163,641.93, while Guilford county produced the greatest amount of clay products, which were valued at $110,974.

The county whose total mineral production was greatest in 1901 was Jackson, the value of the production being $163,659.93.

BULLETINS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*

2. Building Stone in North Carolina, by Joseph A. Holmes and J. Volney Lewis. *In preparation.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and Geo. B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Postage 10 cents.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 2 cents.*

8. Water Powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage ½ cents.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Postage 10 cents.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage ½ cents.*

12. Drinking Water Supplies in North Carolina, by Joseph A. Holmes. *In preparation.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Reis, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. Mica Deposits and Mica Mining in North Carolina, by Joseph A. Holmes. *In preparation.*

15. Mineral Waters of North Carolina, by F. P. Venable. *In press.*

16. A List of Elevations in North Carolina, by J. A. Holmes and E. W. Myers. *In preparation.*

17. Historical Sketch of North Carolina Scientific and Economic Surveys; and Bibliography of North Carolina Geology, Mineralogy and Natural History, by J. A. Holmes and L. C. Glenn. *In preparaton.*

18. Road Materials and Construction, by Joseph A. Holmes and William Cain. *In preparation.*

19. Corundum and the Peridotites in Western North Carolina, by J. H. Pratt and J. V. Lewis. *In preparation.*

20. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe. *In preparation.*

ECONOMIC PAPERS, No. 1, on the Maple Sugar Industry in Western North Carolina, by W. W. Ashe; No. 2, on recent road legislation in North Carolina, by J. A. Holmes; No. 3, on Talc and Pyrophyllite Deposits in North Carolina, by J. H. Pratt; No. 4, on the Mining Industry in North Carolina for 1900, by J. H. Pratt; No. 5, Road Laws of North Carolina (out of print), by J. A. Holmes; No. 6, on the Mining Industry in North Carolina for 1901, by J. H. Pratt; are also distributed free, on the payment of postage, 2 cents in each case, except No. 6, which requires 4 cents.

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